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CIRCULATION THIS ISSUE
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CARVING A ROADWAY THROUGH ROCKY CHINOOK PASS HIGH IN THE HEART OF THE BEAUTIFUL CASCADE MOUNTAINS IN THE STATE OF WASHINGTON

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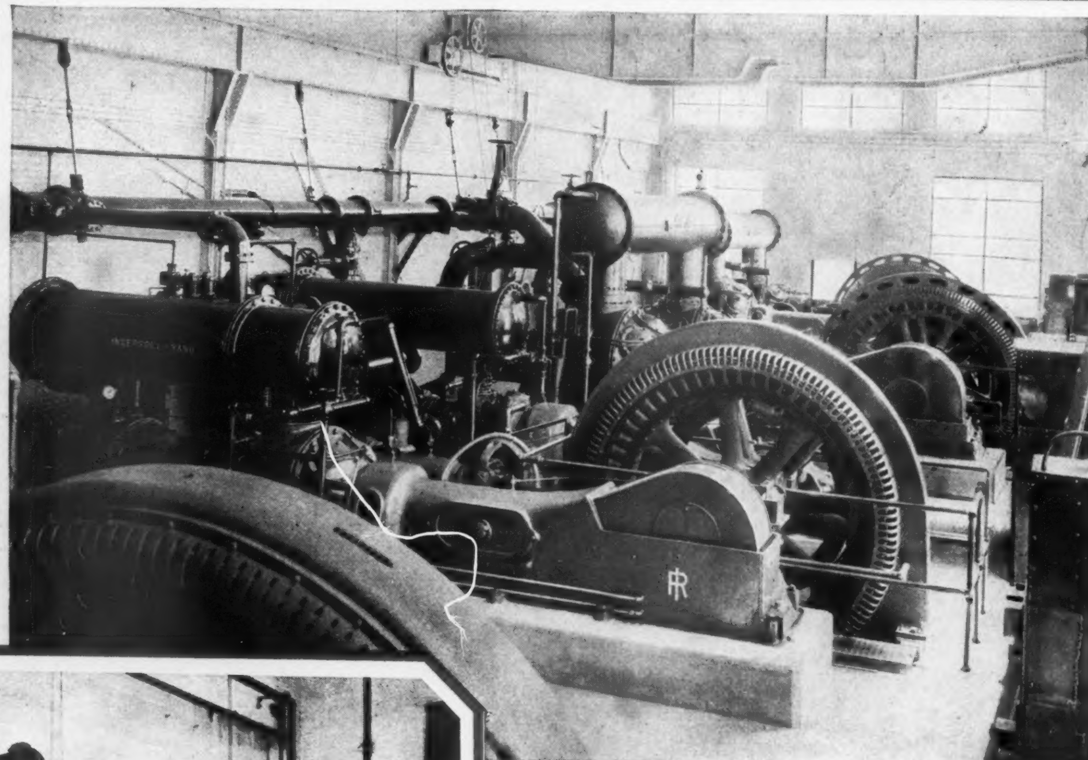

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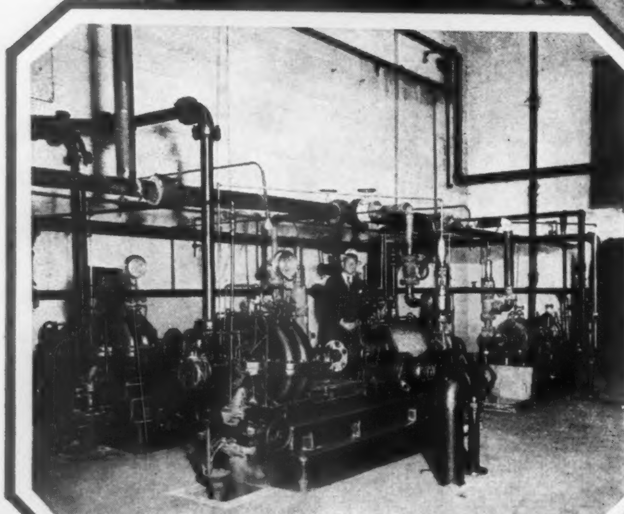


As It Seems To Us

ELECTRIC CURRENT FROM WIND ROTORS

WINDMILLS have been doing service for hundreds of years; and air turbines have been utilized for various purposes for decades. Now comes an effort to adapt the rotor principle in a manner that will make it possible to generate electric current on a worthwhile scale. An experimental unit is in course of construction at West Burlington, N. J.; and it seems that a number of public-service companies are financing the undertaking. How far those concerns will go in the erection of other plants will depend upon the results obtained at the one now in hand. The first unit, so it is reported, will involve an outlay of $100,000, but subsequently, if all goes well, the unit cost may be reduced to $40,000.

With the plant at West Burlington meeting the expectations of its inventor, it should generate about 1,000 kw. when operating in a 28-mile wind. We will not at this time make any effort to touch upon the details of the apparatus. The cost already stated plainly indicates that the plant is far from a mechanically simple one. In short, it bears no resemblance to the windmills and the air turbines that most of us have seen. In the last analysis, the effectiveness of the wind rotor as a source of electricity will, naturally, depend upon the availability of sufficient wind to operate it; and in the absence of trade winds, or of winds of dependable frequency, it is plain that a wind-rotor electric plant can be used only as a standby for other plants that can be made to furnish energy at any time.

WORK AT HOOVER DAM SITE

A LITTLE more than a year ago—to be precise, on September 17, 1930, RAY LYMAN WILBUR, Secretary of the Interior, formally inaugurated work on the Hoover Dam project by driving a silver spike in the first tie of the railroad that now links Las Vegas, Nev., with the dam site. In the meanwhile, both the Federal Government and the Six Companies, Inc., have gone forward diligently in the desert in creating facilities and in concentrating machinery so that the vast undertaking may be advanced with all practicable dispatch.

Progress on the major features of the project has hinged upon a tremendous amount of preliminary labor. The magnitude of these preparations must be seen to be appreciated; but a fairly good understanding of the requirements can be had when it is realized that the dam site is set in an isolated region where physical and climatic circumstances add greatly to operating difficulties. Miles and miles of roads have been built where heretofore only trails existed, and even those were woefully few. Where only sagebrush dotted the desert a few months back, Boulder City now stands; and within that well-regulated community's limits there are today comfortable accommodations for 3,000 persons, as well as associate conveniences that contribute to the well-being, the comfort, and the diversion of the inhabitants.

No one can change the trying climate of the section, but ingenuity and modern engineering can make the summer heat of such a region more tolerable and less of a physical stress upon humankind. Means to this end have been provided, thanks to the foresight of those responsible for the equipping and the managing of this town so suddenly called into being.

To carry motive power to Boulder City and the dam site it was necessary to construct an electric transmission line nearly 235 miles long; and thus to make that energy available the Southern Sierra Power Company had to spend about $1,500,000. At present, the Six Companies, Inc., the general contractor, is principally engaged in driving adits and in advancing headings in connection with the four immense tunnels that will divert the water of the Colorado River during the period that the dam is being reared. In this and other preliminary work, the Six Companies, Inc., has already expended a sum approximating $4,000,000.

Both Government officials and representatives of the contractor are well pleased with the progress made. With the initial stages of the task either mastered or well towards standardization and coördination, there is every reason to believe that the undertaking will go forward henceforth upon schedule. Everyone concerned is to be congratulated upon the showing already made.

WHY THE "NAUTILUS" FAILED

IN THESE days of so many spectacular successes in what might be termed exploratory fields, every broad-minded person should feel sorry for Sir HUBERT WILKINS in his failure to traverse the Arctic Ocean and to cross the North Pole in an undersea craft. It is quite conceivable that had the venture been carried through as planned it would have added considerably to our present knowledge of those frigid waters and especially about physical conditions prevailing beneath the surface.

From all that has so far reached the public, the circumstances of the trip were often disquieting and at times decidedly alarming. One can easily imagine the state of mind of most of the personnel when the *Nautilus* entered the ice fields, where all hands had a foretaste of what would lie before them were it possible to make the complete projected polar run. Every person aboard had ample reason for rejoicing that the vessel survived that baptism of ice, so to speak, and was able to make her limping way back to Bergen.

The thing that stands out conspicuously in the whole enterprise is the questionable wisdom of choosing, in the first place, to make use of a submarine that the United States Navy had put out of commission because she was for all practical purposes obsolete. Boats of her period were not designed for long ocean runs; and her engines and some of her other essential equipment had been impaired by years of service. With initial handicaps of that sort, it was little more than a doubtful gamble to try to adapt the craft to the extremely rigorous demands that would be made upon her in an Arctic trip.

The idea of the expedition has much to commend it. We are still inclined to believe that a submergible vessel designed especially for the work, and provided with up-to-date equipment of every kind, could negotiate the polar sea and travel beneath the ice that prevails there. A craft so built and competently operated might be the means of making scientific discoveries of great value. If Sir HUBERT WILKINS be undismayed by his first trip and fully determined to make another try, we hope he will have a suitable boat for his second essay.

LOOKING FOR TROUBLE

CHRISTOPHER COLUMBUS crossed the Atlantic in a small craft because he lived at a time when big ones were not built for deep-sea voyaging. He accepted the limitations of nautical life at that period and sailed valiantly westward because he was fired with uncommon zeal. Since his day much has been written disclosing the hardships that that intrepid navigator encountered; and the inconveniences of that distant era were brought home to the populace by the reproduction of the caravels of COLUMBUS that came across from Spain to participate in the World's Fair held at Chicago in 1893.

With the foregoing records and full-sized reproductions, one marvels why, as recently announced in the *New York Times*, another replica of the *Santa Maria* should be built in Spain for the purpose of doing in this age and generation what Columbus did in 1492. The boat, with a crew about half as numerous as that aboard the original *Santa Maria*, is to sail for America during the coming winter. We are informed that the purpose is to duplicate Columbus' experiences—even eating hardtack and inviting disaster by omitting from the outfit all navigational aids that have been devised in the intervening centuries! We are at a loss to see any excuse for the needlessly hazardous voyage.

Drawing by F. W. Egloffstein from sketch by Lieut. Ives

Black Canyon as it seemed to Lieut. Joseph C. Ives in 1857.

Drawing by J. J. Young from sketch by H. B. Mollhausen

Ives' little steamer "Explorer" making her way through Mohave Canyon.

America's Wonder River---The Colorado

*How Nature Formed This Amazing Watercourse and How Man Has Had to Face Many Hazards in Discovering It and in Completing Its Exploration**

By R. G. SKERRETT

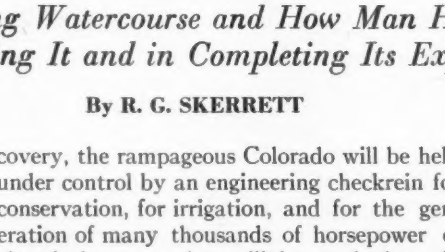
NEARLY four hundred years ago, a white man gazed for the first time upon the Colorado River. No one will ever know who was the first human being to look upon that stream.

That amazing waterway might have remained unknown to white men for centuries longer had not an insatiable greed for gold spurred the *conquistadores* to seek still greater riches than they had been able to wring from the hapless Montezuma.

Since Hernando de Alarcon discovered the Colorado in 1540, and struggled valiantly a considerable distance upstream against its muddy and turbulent currents, very little has been done to control its flow or to convert its tremendous forces into a form of energy that could be put to commensurate and befitting services.

Now, by reason of collaboration on the part of the seven states directly affected and the Federal Government, the construction of monumental Hoover Dam is underway in Black Canyon. If all goes well, that titanic structure will be finished five years hence. Thus nearly 400 years after its discovery, the rampageous Colorado will be held under control by an engineering checkrein for conservation, for irrigation, and for the generation of many thousands of horsepower of electrical energy that will be used throughout a wide radius to do a vast deal of work.

The real significance of this approaching transformation can be better understood if we delve a bit into the dim past of this wonderful waterway. Only by so doing can we grasp why the river is as it is today—unique not only because of its magnificent and even appalling scenery but also because it is unrivaled as an impressive example of what the erosive forces of wind and water can do when acting over a long, long stretch of time. The Colorado has been millions of years in the making.



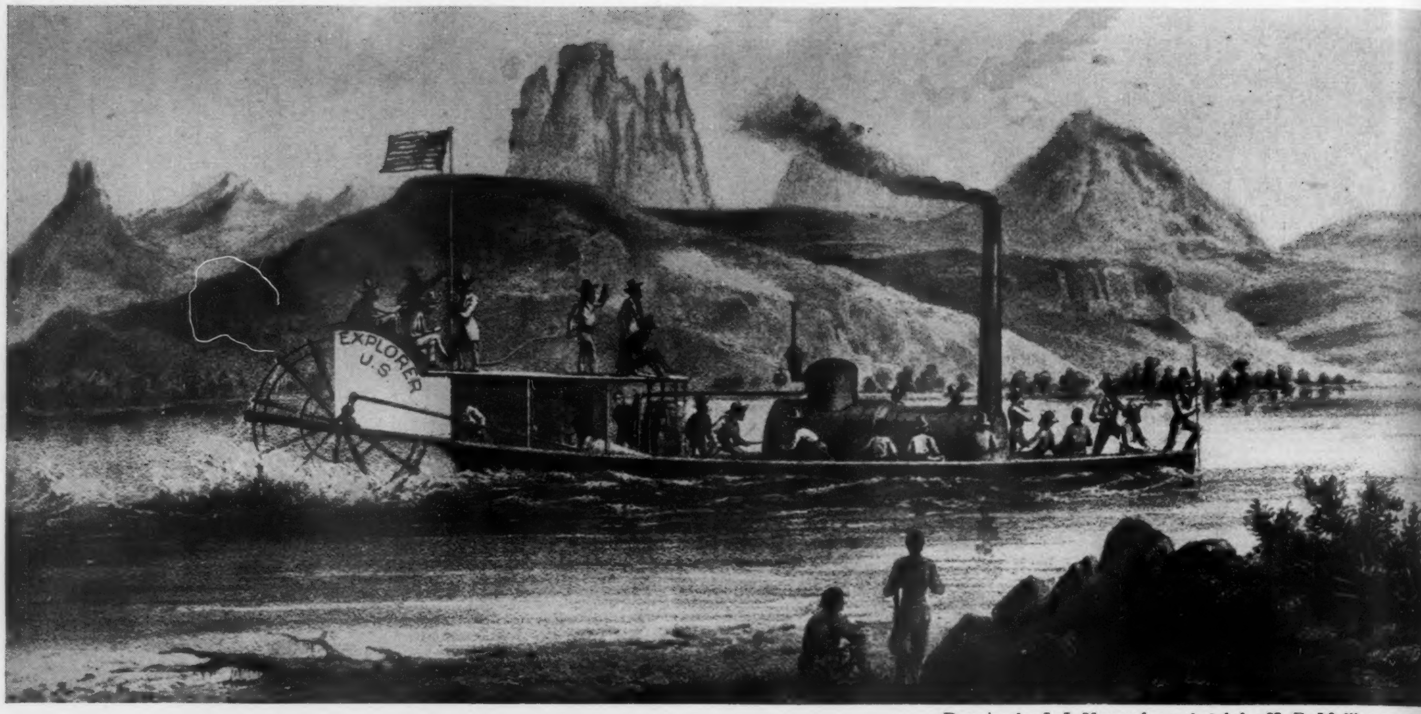
Drawing by F. S. Dellenbaugh

How Alarcon's caravels battled with the bore at the mouth of the Colorado in 1540.

The Colorado and Its Course

From source to mouth, the Colorado has a total length of 1,700 miles; and today it drains an area of approximately 244,000 square miles. Once upon a time the Colorado had a much shorter route to follow before it reached the sea; and then, as now, something like 75 per cent of the water discharged by it had its origin in the glacial and snow-capped mountain ranges forming the watershed of its northern basin. Much of the hundreds of miles of the marvelous canyon sections of the present then lay submerged beneath a comparatively shallow sea—an inland extension of what we now know as the Gulf of California. As the ages passed, the river carried to its estuary enormous quantities of sand

**First of a series of articles on the Colorado River and the building of Hoover Dam.*



Drawing by J. J. Young from sketch by H. B. Mollhausen

Steamer "Explorer", commanded by Lieut. Ives, making her way up the Colorado in 1857. Chimney Peak is seen in the distance.

gathered by its ramifying tributaries, and thus layer by layer a blanket of ever increasing depth was laid on the water bed. Then came a period of momentous change.

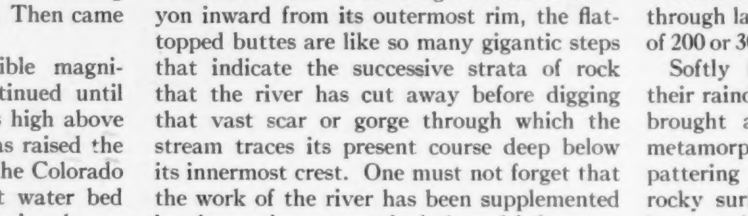
Internal pressures of irresistible magnitude started an uplift that continued until the Sierras reared their shoulders high above the sea, and at the same time was raised the estuary into which what we call the Colorado then emptied—transforming that water bed into dry land. Then and there the river began to cut its way through the sand to the sea beyond—thus reversing the process by which it had previously formed that deposit, thousands of feet in thickness.

Where the course of the river was a leisurely one, it carved for itself a generously broad right of way; and where its descent was abrupt and its flow rapid, the stream eroded a narrow and correspondingly deeper channel for itself. Geologists tell us that the region was subjected to three great uplifts, each uplift being from 2,000 to 3,000 feet above the sea. There are evidences that the region was successively raised and submerged. These tremendous alterations occurred over the inconceivably protracted period of five geological eras—the Colorado, the while, tirelessly cutting a course through sands or rocky structures as they arose athwart its path. In this manner the canyons have been formed. Today, the river is eroding a channel through the great basic stratum of hard black gneiss. The Grand Canyon, in particular, bears mute and appalling testimony to the ages and ages that have gone their several ways into the dim past since the river began its tireless and irresistible work. Following the Grand Canyon inward from its outermost rim, the flat-topped buttes are like so many gigantic steps that indicate the successive strata of rock that the river has cut away before digging that vast scar or gorge through which the stream traces its present course deep below its innermost crest. One must not forget that the work of the river has been supplemented by the erosive sweep of winds and infrequent rains—these agencies still continuing to modify the modeling of the buttes exposed to them.

The magnitude of this total erosive action is incomprehensibly great. We are authoritatively informed that no part of the whole region has been worn down, degraded, less than 1,000 feet; and there is one area of more than 200,000 square miles in extent that has been degraded on an average of more than 6,000 feet. This erosion has been wrought in various kinds of limestone, sandstone, quartzite, and granite—not to mention a stretch of 50 miles where the river has cut its course through lava poured into the gorge to a depth of 200 or 300 feet by erstwhile active volcanoes.

Softly falling snowflakes, clouds spilling their raindrops at lower levels have, together, brought about this staggeringly wonderful metamorphosis. The melting snows, the pattering or beating rains have changed rocky surfaces to sands, and mountain rills have carried the sands into neighboring creeks. The creeks, in their turn, have conveyed the sands to rivers, and the rivers, in their turn, have borne the sands to the Colorado. At each step the abrasive action of the sand has been intensified. In short, the river, after its manner, has performed in a magnified degree not unlike the relatively diminutive saws that man employs in the cutting of blocks of granite or stone of lesser hardness. And the sand that has been used by the Colorado in carving its canyons has finally come to rest in the far-flung delta that has been built up contiguous to the Gulf of California. This burden of silt averages annually sufficient to cover an area of 80,000 acres to a depth of one foot; and this rate of deposition has been going on for an untold period of time. In other words, the very substance of the great plateau through which the Colorado has made its way is being moved ceaselessly from the distant interior to the border of the Pacific Ocean.

The Grand Canyon of the Colorado lies between the Paria River on the north and Grand Wash Cliffs, 278 miles downstream to the south and



U. S. Bureau of Reclamation

All that remains of the old Town of Callville built by the Mormons in 1864. Callville was the head of navigation for craft ascending the river from Yuma.

G. H. Bishop

Spectacular section of Marble Gorge illustrating the vast and continuous erosive action of the Colorado River.

U. S. Geological Survey and E. L. Kolb

Left and right—Sections of Marble Gorge. Center—Engineers of the United States Geological Survey at work in Marble Gorge.

west. Its greatest width is thirteen miles, and at its deepest point it measures 6,000 feet from rim to water level. Where the various canyons penetrate to the supporting granitic formation, they reveal the very adolescent days of Mother Earth. The walls present a perfect picture of much of the continent's geological past; and the picture is awesome by reason of the story it tells and because of the magnificent scale upon which it is portrayed. In the presence of such a record, man and his measures of time dwindle into the infinitesimal. One stands speechless before the work of the tireless Colorado.

Finding and Exploring the River

Cortez filled the strong boxes of Spain with treasure stripped from the Aztecs; but his aggressiveness and his success multiplied his enemies in Spain as well as in America. To win royal favor he knew that he would have to garner added wealth for his king and for himself. But how to do so was a problem. Then, when the outlook seemed darkest, Alva Nunez Cabeza de Vaca returned from his wanderings between the Mississippi and the headwaters of the Rio Grande. De Vaca repeated the tales of a friendly Amerind or Indian who told of rich cities, visited by him when a boy, that lay somewhere to the westward of the Rio Grande. The Amerind had seen silversmiths fashioning jewelry and plate of precious metals in large quantities. These tales were amplified by an imaginative Negro, one Estavan, also a member of de Vaca's party. This was in 1536; and instantly Cortez was moved to action—he wanted to be the first to reach and to plunder the so-called Seven Cities of Cibola.

With funds obtained by pawning his wife's jewels, Cortez equipped three caravels commanded by Francisco de Ulloa; and dispatched them from Acapulco in quest of a point northward that would make it easy for the Spaniards to reach the reputedly opulent cities from the coast. Nothing untoward happened until Ulloa found his craft in the midst of rapidly shoaling water and swift currents, and with shores closing in on them where the open sea was expected. Ignorant of the coast, Ulloa had reached the headwaters of the Gulf of California—the existence of which was unsuspected. Grave, indeed, was the peril when the incoming tide, in the form of a high and roaring wave, swept toward the vessels—that startling phenomenon being due to a range of 36 feet between high and low water and to the narrowed passage the water had to follow during the changing tides.

As Ulloa wrote in his tragic report to Cortez: "We always found more shallow water and the sea thick, black, and very muddy.... We rode all night in five fathom of water, and we perceived the sea to run with so great a rage into the land that it was a thing much to be marvelled at; and with the like fury it returned back again with the ebb, during which time we found eleven fathom water, and the flood and ebb continued from five to six hours." Whence came the waters that poured seaward with the ebb was a matter of wondering speculation; but neither Ulloa nor any of his followers realized that they were at the mouth of a great river.

Ulloa was no coward; but he was an experienced seaman who recognized his perilous predicament. Therefore, instead of waiting for his caravels to be battered to bits by a recurrence of the bore, he sailed southward to more open water. From there he sent one of his craft back to Acapulco with the story of his failure, and with this done he rounded the southern tip of Baja California and headed away with his remaining ships on a voyage that carried all hands to eternity.

Ulloa's failure, and the subsequent killing of the Negro Estavan when he and Friar Marcos tried to reach the Seven Cities of Cibola by an overland route, did not deter the Spaniards—it rather added fuel to the flame of conquest that burned in their breasts. Accordingly, Cortez' viceregal successor, Mendoza, equipped two expeditionary forces in 1540 for the dual purpose of exploration and conquest. Mendoza believed he could in this way make certain of success. Francisco Vasquez de Coronado lead the land force that was to follow the coast northward from Compostela; and the nautical force of three

ships commanded by Hernando de Alarcon sailed from Acapulco and reached the head of the Gulf of California towards the end of August. Coronado arrived at Cibola in July, and instead of a place of riches he found a community of adobe huts much like those common to the region today. Two years later Coronado returned to Mexico virtually empty handed and without having effected contact with Alarcon; but the latter achieved the discovery of the Colorado River and blazed the way for subsequent adventures that only men of great courage and determination could have carried to their several conclusions.

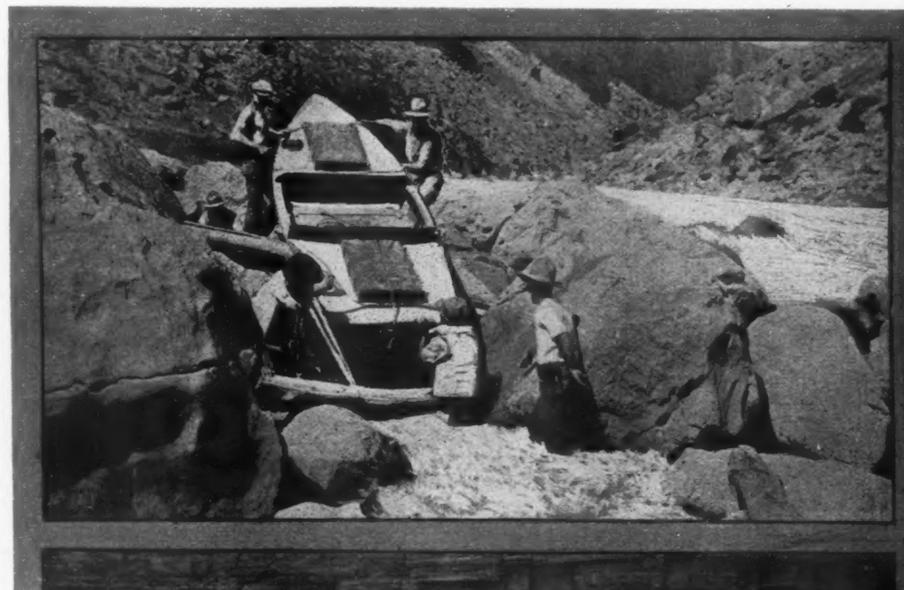
Alarcon was confronted with the same harassing and hazardous conditions that had halted Ulloa; and, had he heeded the advice of his pilots, he, too, would have turned back rather than to risk the destruction of his ships. But, because Mendoza had ordered him to discover the secret of the gulf, Alarcon resolved to push onward despite the risks involved. While the bore swept Alarcon's boats about like toys, and nearly turned them over again and again, still all his caravels survived virtually undamaged; and, when the tide served, the vessels were maneuvered into the channel. As Alarcon reported: "It pleased God that after this sort we came to the very bottom of the bay, where we found a very mighty river, which ran with so great a fury of a stream, that we could hardly sail against it."

When he had his craft where they could be moored and protected against the direct force of the bore, Alarcon provisioned and armed two boats for a trip farther up the river. The current soon proving too strong to be rowed against, most of the crews were landed and set to the task of towing them. It was hard work for men unfamiliar with that form of labor: and when inquisitive and seemingly hostile Indians gathered on the banks, Alarcon had the wit to make friendly gestures instead of firing his guns to alarm them. Furthermore, by suitable pantomime, he made them understand that the Spaniards represented the Indian's sovereign lord, the Sun. From that time on for a number of days the natives vied with one another to put their shoulders to the tow lines. Alarcon made two trips up the waterway, and the highest point reached by him on his second expedition was somewhere about 50 miles above the mouth of the Gila River. Failing then to make contact with any of Coronado's lieutenants, Alarcon returned to his ships, which were badly damaged by the *teredo*, and hastened southward to a suitable port for repairs.

Of Coronado's force only two men reached the Colorado. One of his officers, Melchior Diaz, came to the river after Alarcon had departed; and to Don Lopez de Cardenas, a rollicking member of that expedition, belongs the credit of being the first white man to look down into the depths of the Grand Canyon. He probably did this, so it is believed by competent authorities, at a point somewhere between Diamond Creek and Kanab Canyon. Thus far we have dealt with the actual discovery of the Colorado, so named because of the reddish color of its waters. Now let us touch somewhat briefly upon subsequent explorations over succeeding centuries that finally rounded out our knowledge of the Colorado so recently as 1924.

Following in the footsteps of the gold-seeking *conquistadores* came those gentle-hearted *padres* whose primary purpose was the saving of souls. It was Father Garces who first made continual use of the name Colorado in describing the river. To Fathers Garces and Escalante we are indebted for accounts of different parts of it; and the latter, after traversing a desperately difficult canyon section of that waterway, discovered a place where it could be forded. The route now known as the Crossing of the Fathers bears testimony to the good *padres'* undaunted persistence in the face of appalling odds. This was back in 1776. Decades passed with no records of white explorers along the Colorado until James O. Pattie, a venturesome trapper, followed the river all the way from its mouth to its headwaters—being in all probability the first white man, if not the first person, to do so. Pattie's journey was made during the "twenties" of the past century. Pattie traveled both on foot and mounted.

To Gen. William Henry Ashley, a fur trader, belongs the credit of being the first to go by boat down any of the canyons of the Colorado. Most of his perilous voyage was down the Green River, and was made in 1825 in craft covered with buffalo skins instead of wooden sheathing. The account of this trip abounds in thrills. Several members of his party were drowned; and the expedition traversed some



U. S. Geological Survey

Top—Where boats of the Survey journeyed overland at a point in Soap Creek Rapids. Center—Running the rapids below Havasu Creek. Bottom—Repairing one of the boats after reaching Badger Creek.

of the worst rapids in the canyons of the Colorado system. Of the excellent work of Lieut. W. H. Hardy, R. N., we can only refer to the fact that he explored the Gulf of California in 1825 for a pearl-and-coral fishery association. To him the world is indebted for the first authentic plan of the lowermost part of the Colorado River as well as of the Gila for a few miles above its confluence with the Colorado. Lieutenant Hardy's 25-ton schooner had to battle with the bore as had his Spanish predecessors; and by good fortune and expert maneuvering he managed to save his vessel from destruction.

Without any intent to belittle their performance, we must touch only briefly upon the trip down the canyons of the Green River made by William Manly and six companions—all "forty-niner" teamsters who abandoned bull-whacking to venture afloat upon the "River of Mystery". They were intent upon reaching the Pacific Coast by what they conceived to be a fortuitous and shorter route than that followed by prairie schooners. The craft used was little better than a scow. All went well, despite some narrow squeaks at several points, until the scow was smashed for keeps on the rocks in the rapids of Ashley Falls. From there on those high-spirited young men made their way overland.

The continual lure of gold in California, and the need of a military post near the junction of the Gila and the Colorado, caused the United States Government to make its first attempt to explore the Colorado in 1850. Lieut. George H. Derby of the Army was ordered to enter the Colorado as far as the Gila in a sailing vessel of 120 tons. The *Invincible*, as she was named, was handled by a veritable sailor who, when the roaring flood tide hit her and she seemed doomed, saved the craft by prompt and decisive action. Derby's penetration to the Gila led shortly afterwards to commercial voyaging upon the lower reaches of the Colorado. George A. Johnson, the pioneer in this field, built a flotilla of barges and later operated one or more stern-wheel steamers on the river above Yuma. Johnson's work undoubtedly inspired the Government expedition of 1857, which was commanded by Lieut. Joseph C. Ives of the Army.

Ives' vessel, the *Explorer*, was delivered dismantled at the head of the Gulf of California; and there, in the muddy delta of the river, a basin was excavated in the soft ground and the assembling of the stern-wheeler was begun. In about a month the craft was so far finished that steam could be raised in her boiler and her engine turned over. Five days later, at high tide, with a passage cleared from the basin to the waterway, the *Explorer* was successfully launched. In the course of the work cut out for him, Ives navigated his vessel upstream as far as the mouth of Black Canyon. There a sunken rock blocked the way and just missed damaging her irreparably. That ended further upstream exploration with the steamer. When suitably repaired, the return journey was begun. The *Explorer* was disposed of at Yuma; and it is interesting to point out that her hulk was recently uncovered in the sands of the delta a number of miles from the present course of the river—the erstwhile channel having been shifted during the flood period of 1909.

Most of what we now know about the Colorado is mainly due to the daring of those explorers who successively ventured upon the river between 1869 and 1924. Some of them faced, with other perils, death by starvation; and in more than one instance they headed with grim determination into the unknown—an unknown reputed at points to entail plunges into the very bowels of the earth. Our geological, hydrographic, and photographic understanding of the Colorado, may, without disparagement to others, be attributed to the discoveries and the activities of Maj. J. W. Powell, Lieut. George N. Wheeler, Frank M. Brown, Robert Brewster Stanton, Nathan Galloway, Julius F. Stone, the Kolb brothers, and E. C. LaRue, with his associates of the United States Geological Survey. LaRue's explorations were numerous and comprehensive, and covered the period between 1914 and 1924.

The work of certain of the foregoing explorers was epochal in its revelations, and members of some of the parties lost their lives in their splendid efforts to strip the Colorado of the very last of its mysteries. As we shall see in due season, all this courageous venturing was more or less necessary before any successful steps could be taken to curb the Colorado, which has been running its unbridled course for ages. Even now, one wonders at the confidence of Lilliputian man to bind this aquatic Gulliver.

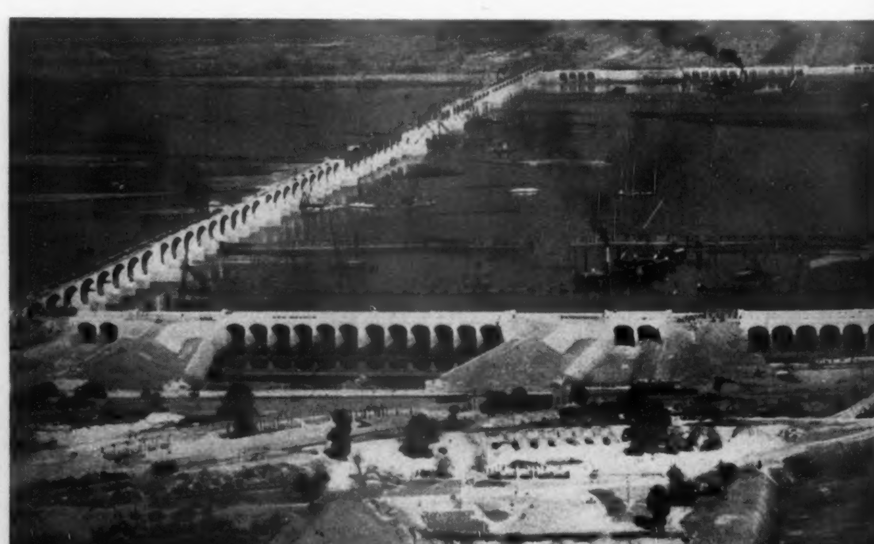
INDIA SOON TO DEDICATE VAST IRRIGATING SYSTEM

EARLY in January of next year the great Lloyd Barrage, spanning the Indus River three miles below Sukkur, India, is to be formally opened to service. Work on the project, which is said to be the world's biggest irrigation scheme, has been underway since October 24, 1923, when Sir George Lloyd, Governor of Bombay, laid the foundation stone.

The barrage or dam is nearly a mile long and its 66 sluice gates will permit a flow, without a fall, of 1,500,000 cubic feet of water per second. The generation of hydro-electric energy was not considered, as there is no market for it. On either bank of the river and extending upstream from the barrage are the canal regulators with intake gates arranged in sets of three working in grooves one behind the other. These gates, unlike those in the barrage, are lowered, as may be desired, to keep the heavily silt laden bottom water of the river out of the canals. Furthermore, the permanent sills of the regulators are from 6 to 9 feet above the floor of the dam so that any accumulation of silt in front of them can be swept downstream through the sluice gates.

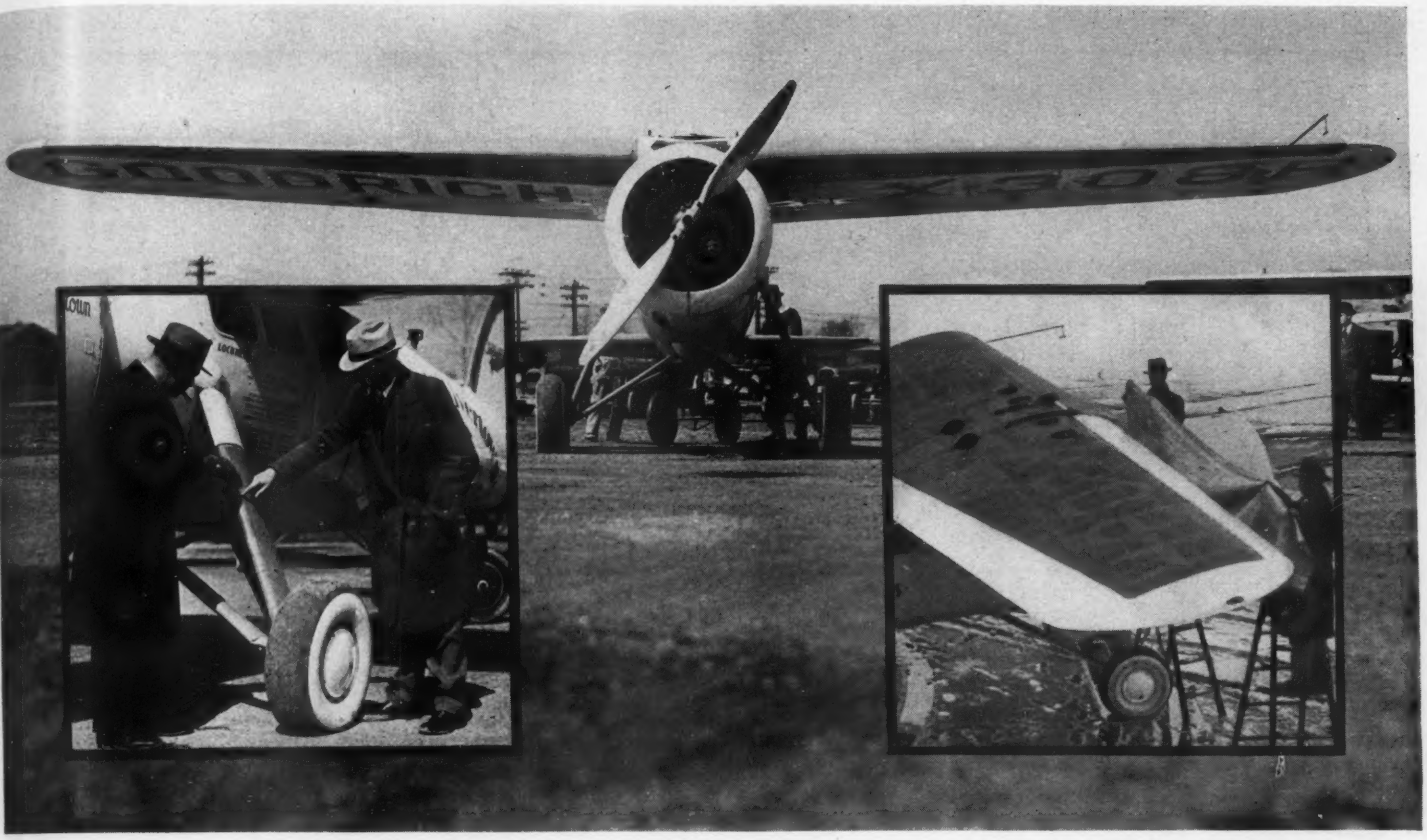
The combined length of the canal and distributing system to be served is 5,295 miles. The main canals, of which there are three on the right and four on the left bank of the Indus, are 805 miles long; the branch canals aggregate 766 miles; and the distributing lines total 3,724 miles—representing an earth-removal job of no small magnitude. All told, 5,600,000,000 cubic yards of earth have been handled in creating this vast network of irrigating canals which will soon deliver water to 8,132,000 acres of land, of which 5,500,000 will probably be put under cultivation.

A stretch of ten miles on each side of the stream has been condemned by the engineers—that is, anyone farming within those areas does so at his own risk. The reason for this is that the course of the Indus is along the top of a ridge, the land on either side sloping away to lower levels. At Sukkur, where the river reaches its highest point, there is a maximum rise during flood periods of 20 feet over low water, causing the Indus to overflow its banks and to inundate the land for miles on either side. The 10-mile strips are therefore in the nature of protective zones, and were deemed preferable to the upbuilding of levees.



Courtesy, Commerce Reports

Airplane view of the great Lloyd Barrage in course of construction. On either side of the 4,725-foot dam are the regulators that feed a 5,295-mile irrigating canal system.



"Miss Silvertown" completely equipped for ice removal. Inserts, left—Close-up of one of the wheel struts. A zipper fastener holds the overshoe in place. Right—Applying the Goodrich de-icers to the craft's wings.

Overshoes Free Airplanes of Ice

AIRPLANE pilots should no longer dread flying in wintry weather because they have been given a means that is said to effectually rid their craft of ice, the weight of which, if permitted to accumulate, might spell disaster. Engineers of the B. F. Goodrich Rubber Company have invented what are termed "de-icers", overshoes that can be quickly fitted to various parts of a machine and as easily detached when they are not required. The protective coverings are made of rubber, and they house tubes of the same material that are inflated with compressed air. In this way the elastic members, when coated with ice, are caused to expand and to break up the layer into small particles that are carried away by the wind induced by the speeding plane.

The researches in the United States that ultimately led to the development of the new safety feature started back in 1922. Many liquids were tried and different fabrics were spread over the wing surfaces to prevent the formation of ice. None of these, however, was a satisfactory solution of the problem. Finally, after the Guggenheim Foundation had besought the aid of Dr. William C. Geer, former head of the Goodrich research laboratories, it was decided that it was not a question of ice prevention—that some means or method was needed that would remove the ice after it had formed on the surfaces exposed to it.

With that conclusion reached, a refrigerated wind tunnel of large proportions was constructed at the Akron plant of the Goodrich Rubber Company for the testing of ice-removal equipment under conditions simulating those encountered in service. In this tunnel it was possible to create a wind with a velocity of 80 miles and more an hour and to lower the temperature to zero Fahrenheit so as to coat with ice the airplane wing section installed in the tunnel. To detail all the steps in the laboratory work that followed would be wearisome: it is enough to say that the original shoes functioned so well when compressed air was forced into their contained tubes that the investigators were convinced they were on the right track and pursued their studies accordingly.

Late last December the wings of a National Air Transport mail plane were equipped with de-icers. During her test flights the machine was made to penetrate cloud formations that, under ordinary circumstances, it would have been hazardous to venture into. Much ice had to be contended with; but almost as quickly as it formed it was broken up by the pulsating overshoes—the swift current of air induced by the speeding craft picking up the pieces and carrying them away.

Wings, however, are not the only parts of a flying machine that need to be provided with ice-removal equipment to assure safety in flight in freezing temperatures. Therefore the investigators next turned their attention to the making of overshoes for wires, struts, etc. As a result, the Goodrich test plane, *Miss Silvertown*, was completely shod for the casting off of ice early in 1931. Tailored "rubbers" were snapped on to her wings, fastened with zippers to her struts, and laced on to her tail surfaces. With the mounting of an automatically operated air compressor on her motor, the installation was complete.

Miss Silvertown was first taken aloft by a seasoned pilot to determine the effect of the overshoes on the craft's behavior in flight. According to the reports, little if any difference was noticeable between her movements when she was maneuvering with or without the de-icers. Her performance otherwise is said to warrant the opinion of her owners that the art of aerial navigation has been considerably advanced because of the availability of a thoroughly practical means of ice removal.

If you would have the new paint on your house last longer than it usually does, use aluminum paint as a primer, especially if much summer wood has gone into its construction. While it is not a cure against flaking, the aluminum primer is said to increase considerably the life of the top coat and to protect the wood more adequately against weathering. Summer wood, let it be said, does not hold paint as well as spring wood, which has larger cell cavities.

Susquehanna River viewed from a towering headland just below Safe Harbor. Top, from left to right—Evolution of the tobacco pipe from a thing of crude pottery to a type with a carved bowl of Susquehannock origin. Ornamental combs fashioned by Susquehannocks. Different steps followed by the Susquehannocks in making fishhooks from a bone blank.

The patient and painstaking work of excavating relics in an ancient Indian grave.

Science and Big Business Join Hands in Archaeological Research

Work Lately Done in the Lower Susquehanna Valley Has Uncovered Amazing Facts About the Aborigines Who Lived There Hundreds If Not Thousands of Years Ago

By A. S. TAYLOR

STALKING the red man on the lower Susquehanna.

Picking up his trail after a lapse of centuries or, possibly, thousands of years.

Such has been the spectacular field work, during the last two years, of the Pennsylvania State Historical Commission under the expert guidance of Dr. Donald A. Cadzow, F. R. G. S.

Astonished scientists might still be all at sea about the aboriginal dwellers of the region contiguous to the Susquehanna had not a great hydro-electric plant been taken in hand at a point adjacent to Safe Harbor, Pa. The construction of that magnificent modern undertaking, now nearing completion, is largely responsible for the fascinating archaeological discoveries that have lifted the veil that has long hidden the story of the remote denizens of the countryside. Indeed, the Safe Harbor Water Power Corporation has not only furnished the funds that made the researches primarily possible but at every stage of the work lent material aid and encouragement to Doctor Cadzow and his associates.

The Susquehanna Historical Expedition—for such the organization has been called—is the outcome of a chance remark made by Mr. John A. Walls, vice-president and chief engineer of the Safe Harbor Water Power Corporation, to Dr. Frederic A. Godcharles, formerly director of the Pennsylvania State Museum. A little over two years ago, Mr. Walls casually mentioned that his company was about to begin the building of a dam on the Susquehanna for the purpose of generating an enormous block of electrical energy. The dam was to raise the normal level of the river more than 50 feet and to create a pond that would extend upstream for 10.4 miles. The dam and the associate power plant were to be ready for service early in 1932.

Doctor Godcharles was much disturbed by the news, because he realized that Walnut Island, a mile or so above the projected dam, would be many feet underwater when the great basin was filled. Certain rocks on the island that bore undeciphered Indian inscriptions would thereafter be far beyond the reach of investigators. That impending archaeological loss was all the more to be regretted because Pennsylvania had done so little in the way of investigating sites within her borders where, according to tradition,

Restored specimens of Susquehannock pottery found 4 feet beneath a street in Washington Borough, Pa.

Indians had dwelt long before the white man penetrated that part of the country.

The situation was aggravated by two factors: The state had no funds to pay for months of hard work that would be needed either in removing the inscribed rocks bodily or in making exact plaster casts or molds of them; and the State Legislature had just recessed and would not reconvene for a year. Before then the dam would probably be completed and Walnut Island immersed! The good doctor showed his anxiety; but Mr. Walls was sympathetic and a man of action. Shortly afterwards, the power company placed $5,000 at the disposal of the State Historical Commission with the understanding that efforts should be made to induce the State to appropriate a similar amount. Since then the Safe Harbor Water Power Corporation has contributed an additional sum of $3,000.

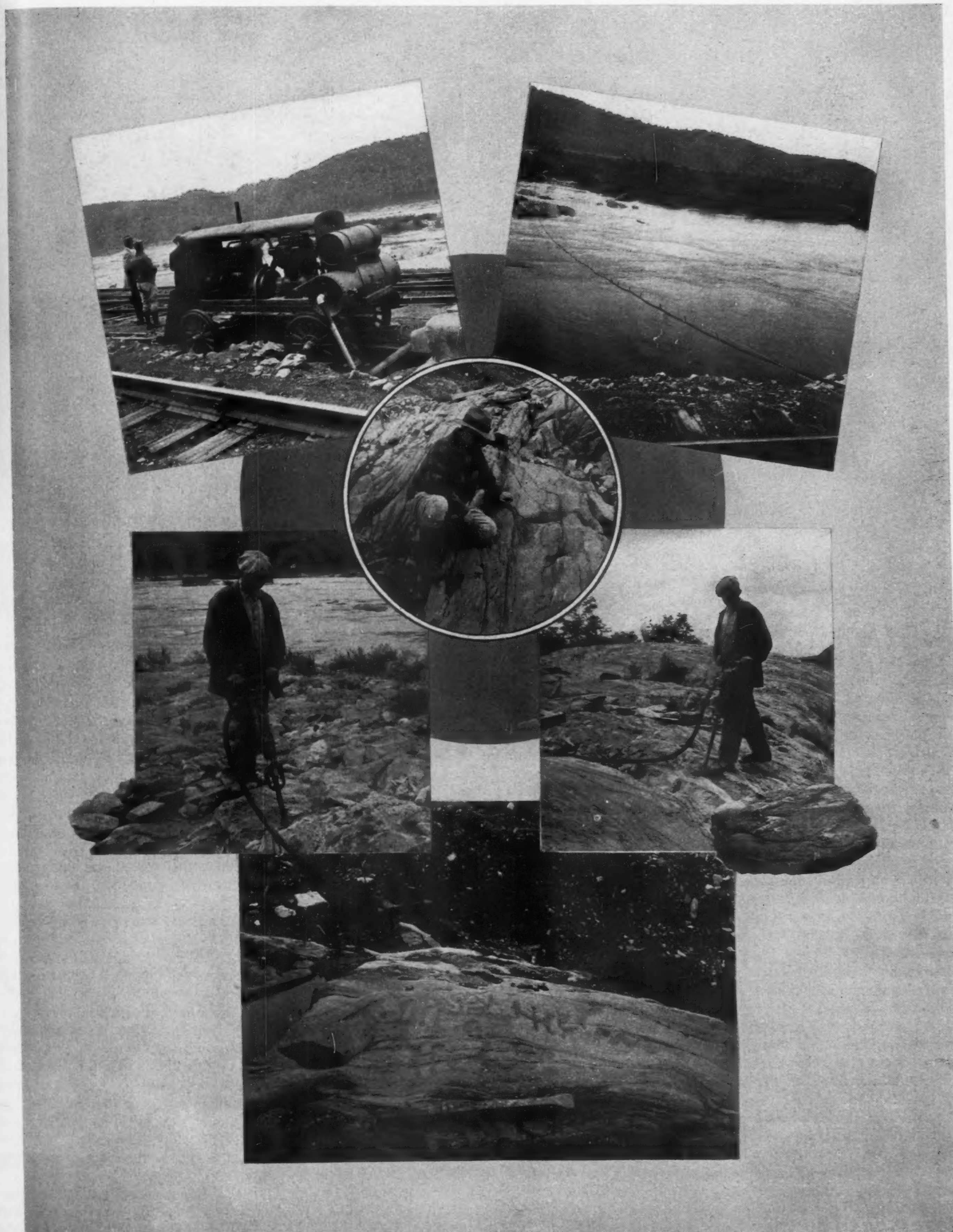
With money available, the State Historical Commission promptly put Dr. Donald A. Cadzow in charge of field activities; and the corporation further provided the doctor and his aids with a comfortably appointed house at Safe Harbor as a base of operation. It also furnished him with a power-driven station wagon and a large and sturdy dory equipped with an outboard motor. Those facilities contributed much to the success of the undertaking. Doctor Cadzow had to work hard against time; and he had scarcely more than finished his task on Walnut Island before the river rose above it. Let us sketch briefly what was previously known about the several Indian occupations of the lower valley.

Big Indian Island and Little Indian Island lie in the Susquehanna a little way below the present dam. Rocks on each bear characteristic symbols of Algonkian origin. They were not decipherable by Indians in possession of the country at the time William Penn's pioneers penetrated that wilderness. Beyond the fact that scientists were reasonably certain that Algonkians had at some time cut those figures nothing more was known about them. The problem to be solved became still more puzzling when Doctor Cadzow examined inscriptions on Walnut Island and subsequently uncovered others of a kindred sort. Don't let us make our story confusing by too much haste in telling it.

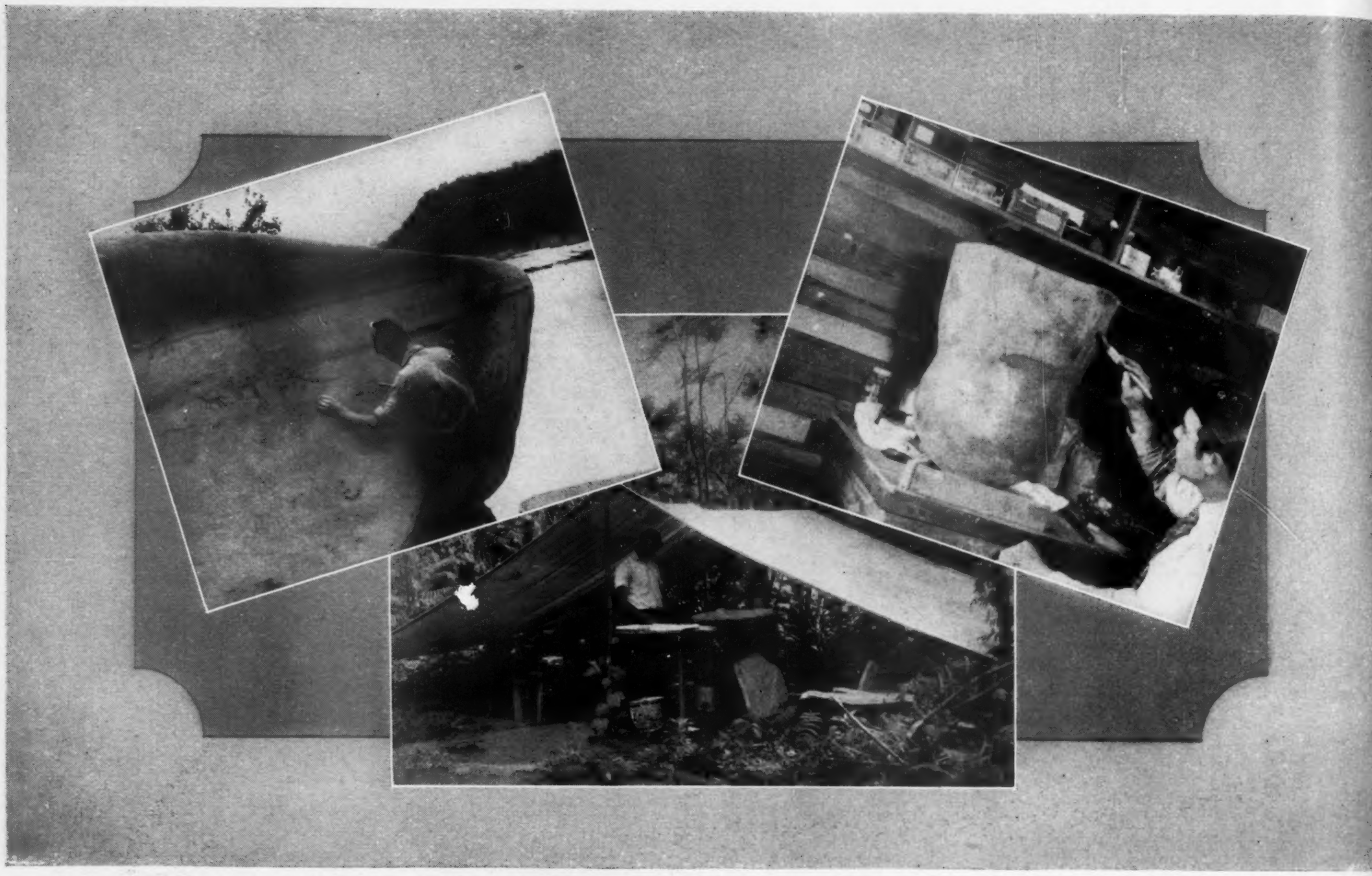
As is the wont of men familiar with archaeological investigations, Doctor Cadzow began his work by questioning old residents of the countryside about Safe Harbor. He was told by rivermen and fishermen that there were Indian carvings on Walnut Island, and he was also informed that the island got its name from a fine stand of walnut trees that had once flourished on it but that had been cut down and rafted to a ready market. The cutting of those trees had exposed the earthy overburden of the island to erosion by wind and rains—thus reducing the thickness of the cover that had lain upon it in the past. Subsequently, a settler upon the island dug a race on the west side to lead water to a mill that he never built. However, that channel offered a ready passage for the surging waters of a spring flood that swept down the Susquehanna in 1889. The flood tore away a considerable section of the western side of the island and, possibly, aided by previous erosion, brought to light the first of the Indian markings seen there by white men on the exposed rocks. It was to examine those rocks that Doctor Cadzow was rowed by a local boatman at the very beginning of his explorations.

Petroglyphs made on Walnut Island during the first period of Indian occupation. The inscriptions were brightened with chalk to make them readily discernible.

The doctor recognized at once that the petroglyphs were radically different from those cut by Algonkians on the rocks below the dam. The figures intrigued him, and he decided then and there to start work on Walnut Island with all possible dispatch. The symbols were rather simple and notably conventionalized. Furthermore, they were astonishingly well preserved. This was not because they were of a later date than the figures cut in the rocks below the dam, but due, in all probability, to



Top left—Portable compressor on mainland that furnished air to operate rock drills on Walnut Island. Right—The ⅜-inch steel cableway supporting hose that carried the air to Walnut Island in the Susquehanna River. Circle—Dr. Donald A. Cadzow viewing one of the most intriguing petroglyphs uncovered on Walnut Island. Center, left—This paving breaker was used to clear away fissured rock preparatory to removing a large slab bearing prehistoric Indian petroglyphs. Right—Drilling a line of closely spaced holes with an R-12 "Jackhamer" in freeing masses of rock inscribed with Indian petroglyphs. Bottom—The puzzling petroglyphs carved in the rocks of Walnut Island by ancient Indians that preceded both the Algonkians and the Susquehannocks.



Left—Algonkian rock pictures exposed by low water at a point downstream from the Safe Harbor Dam. Right—Restoring a pottery vessel made by the Susquehannocks, "the people of the rolly river". Bottom—Headquarters on Walnut Island, where plaster casts were dried and crated for shipment to the State Museum at Harrisburg, Pa.

the fact that they had been long buried and therefore not exposed to weathering. Doctor Cadzow reasoned that if they were truly of ancient origin, then the hands that engraved them possibly cut other characters of the same nature elsewhere in the rock formation. Accordingly, he set a crew with picks and shovels to digging near the point where the first of the petroglyphs had been bared by nature. His husky lads toiled diligently and excavated a trench along the limestone outcrop. The day was a sizzling one; the work was back breaking; but not a single encouraging sign was visible when a halt was called for the noonday meal.

All hands ate their luncheon in a gloomy mood in the shade of a shelter tent; and it was agreed to move to another site if the afternoon's work in the trench and test pits produced no results. And now we come to another stage in the history of these ancient records where nature was again to do her part in revealing the secrets of the past.

A thunderstorm had been brewing for some while. Before the afternoon ended, the clouds burst and the rain fell in nearly solid sheets for more than an hour. There was a still heavier downpour farther upstream that swelled the river and set it rushing tumultuously past the island. Both the river and the rain washed clean rock surfaces that had been only partly uncovered by the diggers. In a span of minutes, hard-packed sand was carried away that had probably lain undisturbed upon the rocks for untold centuries. When the rain ceased and the river fell, to the wonderment of all, more undecipherable and strange figures were exposed! They showed an indubitable kinship with the inscriptions that had first arrested Doctor Cadzow's attention. The last of the petroglyphs had been separated from the first by a covering of 8 feet of earth—evidence that they might have been so concealed for one or several thousand years. The party was vocal in its delight at the "find".

Doctor Cadzow has thus described what followed after the foregoing amazing discovery: "Much encouraged, we set to work to test the island thoroughly. It was, of course, impossible to remove several acres of topsoil, so excavations were confined to completely exposing the rocks already found. As new writings were brought to light, an expert from the Rochester Museum made plaster molds of them.

"Thorough tests of the soil and strata at various points on the island revealed a minor occupation by prehistoric Algonkian Indians in the form of typical pieces of worked stone and pottery. However, as these objects were only a few feet beneath the present surface of the island, there is some question as to their antiquity. But far beneath, in the hard-packed sand, were indications of a race that had lived in the Susquehanna Valley long before any of the Indian tribes of which we have any record. Who they were, and to what era they belonged, no one knows".

The striking feature of these petroglyphs of a dim past is their resemblance to the pictographs of the Chinese. Indeed, Chinese students that have seen them have essayed to interpret some of them. Whether they are right or wrong is a matter of speculation. Is it possible that they are the mute records of a people that reached the continent from Asia and migrated eastward ages ago? It has recently been asserted authoritatively that the first men came to this continent from Asia, landing somewhere in the section now known as Alaska.

Walnut Island has played a part in the lives of the Indian groups that have successively occupied the Susquehanna Valley in the centuries gone. Secret rites and councils have been customary among the Indians as far back as any present knowledge goes. There are cavities in the rocks on Walnut Island that tell plainly where council fires were repeatedly built. The position of the island in the river and the dangerous sweep of surrounding waters made it difficult to approach unseen and an ideal place for conferences associated with secrecy. The island might be likened to the lodge room of the white man.

After discovering on Walnut Island traces of early Algonkian occupation, Doctor Cadzow and his men set about seeking examples of their graphic art. These were found in abundance farther down in the middle of the river—notably on Little Indian Rock, also known as Little Indian Island. Algonkian petroglyphs have kindred characteristics wherever found;

and they have been discovered within an area extending from Wyoming to the Atlantic seaboard. These rock figures and symbols may have served a number of purposes: They may have had a religious significance, and they may also have been guides to game, springs, and to other things essential to the life and the well-being of the aborigines.

Among the religious symbols is the widely used one typifying the "thunderbird". According to Indian tradition, that mythological creature carried a lake on its back, and when it flapped its wings water spilled over and descended upon the land as rain. The angry flash of the thunderbird's eyes produced lightning. One significant characteristic of all the petroglyphs is the depth to which they were cut in the first place so that they could survive erosion and weathering over long, long periods of time. They were manifestly inscribed patiently and with much labor—further proof that the work was done for a serious purpose and to endure. In some instances the inscriptions on Walnut Island have been worn away until they are merely shallow traces of their erstwhile depth; and only the sensitively responsive fingers of the trained archaeologist can follow correctly their contours. A number of the rock pictures on Little Indian Island record the footprints of turkeys, deer, bears, and buffaloes. And the frequency of engraved snakes suggests, as do the footprints, the types of animal life that once were undoubtedly abundant in the region.

After the finds on Walnut Island and the examinations of the petroglyphs on Little Indian Island, Doctor Cadzow determined to search the left bank of the Susquehanna for archaeological sites that might be a source of repetitive records and thus throw confirmatory light on the rock carvings in the river. This quest produced amazing archaeological results. Near Washington Borough, a little way up river above Safe Harbor, the doctor and his men located a burial site assumed to hold the remains of Algonkians. Instead, digging revealed the skeletons of Susquehannocks—the race which drove the last of the Algonkians from the region!

The Susquehannocks were an interesting and a powerful tribe; and the Susquehanna Historical Expedition has brought to light facts about them that have completely changed the conception of those aborigines heretofore held by archaeologists and students of American archaeology. There is warrant for the belief that the Susquehannocks were originally of the Iroquois group, and that they came out of the West and over the Allegheny Mountains along about 1300 A. D. —the Bear tribe of the group settling on the Susquehanna and adopting the name of that river. Thus they became known as "the people of the roily river". There is no way of telling how long the two occupations by the Algonkians and Iroquois lasted; and probably it will never be known how long before the first of the Algonkians dwelt there the country was visited by the people who made the mysterious records on the rocks on Walnut Island.

The Susquehannocks were reported by other Indians living close to the shores of Chesapeake Bay to have been in possession of the lower Susquehanna River for untold years before the white man settled in Virginia. They were reputed to be of great size and powerful in battle. In fact, they were greatly feared. To Capt. John Smith we owe a striking picture of the Susquehannocks. Writing about them after contact with them in 1608, Smith stated: "This nation of the Susquehannocks could muster about 600 men, and live in palisadoed towns, to defend themselves against the Massawomecks, their mortal enemies. They were very large, well-proportioned men, and appeared like giants to the English.... Their attire was the skins of bears and wolves, so cut, that the man's head went through the neck, and the ears of the bear were fastened on his shoulders, while the nose and cheek hung dangling down upon his breast. Behind was another bear's face split, with a paw hanging at the nose. One had the head of a wolf hanging to a chain, for a jewel; and his tobacco pipe was three-fourths of a yard long, carved with a bird, a deer, and other devices at the great end, which was sufficient to beat out a man's brain. They measured the calf of the largest man's leg, and found it three-quarters of a yard about, and all the rest of his limbs were in proportion, so that he seemed the stateliest and most goodly personage they had ever beheld."

Capt. John Smith may have been prone to exaggeration, but there is no doubt that the Susquehannocks were a fine and exceptionally big lot physically. Doctor Cadzow confirms this: "One of the skeletons, that of a woman, was so well preserved that a fairly accurate estimate could be made of her height. She was perhaps six feet one inch tall. In the curve of one of her arms was the body of an infant. Another skeleton, that of a man, not so well preserved, indicated a height well over six feet. These remains of both sexes prove that the Susquehannocks were no pygmies."

Doctor Cadzow has obtained a wealth of pottery and other artifacts that establish the Susquehannocks to have been on a plane of development far higher than heretofore believed. They were in this and in other respects greatly superior to the Algonkians whom they exterminated. One cannot help but wonder whether or not the Susquehannocks brought their cultural gifts from the Southwest where kindred advances had been made by the Indians of prehistoric periods. Despite their attainments and their great courage in battle, the Susquehannocks were wiped out as a force on the river in a dramatic and even tragic manner. We can refer to this only in the briefest way. It was the penalty of meddling in the quarrel of others and of being false to one of the traditions of tribal intercourse.

The Hurons in the North were at war with the Iroquois, and the Hurons, being outnumbered by the Five Nations, appealed to the redoubtable Susquehannocks for help. The Susquehannock braves, after years of belligerent inaction, jumped at the chance of a fight. Their willingness to ally themselves with the Hurons was to cost them grievously. The Hurons were soon subdued by the Iroquois, and then the latter turned their attention to the Susquehannocks, with whom they had not come to blows. The Iroquois sent an embassy of twenty warriors to the Susquehannocks to propose a treaty of friendship. The arrogant answer of the Susquehannocks was to massacre every member of the embassy. As a consequence of that treacherous act the Iroquois declared two decades of war—a year of conflict for each slain warrior. In the beginning, because of their strength and their fortified positions, the Susquehannocks were able to hold their own; but in the end they were worn down by superior numbers. Along about 1763, the last of the Susquehannocks' strongholds fell and the survivors of that erstwhile powerful tribe were taken into captivity.

Step by step, Doctor Cadzow and his men have been unraveling the story of the Susquehannocks and the Algonkians by excavating burial and village sites; and possibly they may hit upon some record that will serve as a key to the petroglyphs cut in the ages gone in the rocks in the river. Even if this does not happen, still the expedition has opened to the world vistas of archaeological periods and has recovered artifacts that give an entirely new conception of the lives and cultural attainments of the aborigines of the region.

Making a plaster cast of petroglyphs on Walnut Island.

Those Indians laid the foundation for the economic expansion of the white man who followed long afterwards in the footsteps of those vanished and mysterious peoples.

Many of the most valuable petroglyphs on Walnut Island, thanks to the use of air-driven rock drills, were loosened from the primordial ledge and moved successfully, but at considerable hazard, down river through the rapids to the dam for carriage by rail to Harrisburg. Now, safe in the State Museum, they can be studied deliberately by qualified experts in the years to come; and some day the fascinating problem of their identity and their meaning may be solved.

Doctor Cadzow has performed well the task set him; he has done a great service to science; and it is to be hoped that the archaeological investigations will be continued under trained leadership.

LACQUER RECOVERED FROM SPRAY BOOTH FOR RE-USE

IN THE plant of the National Cash Register Company, at Dayton, Ohio, the lacquer wasted in the process of finishing metal parts is reclaimed at a cost, so *Maintenance Engineering* says, of about one-third that of new material. Below the conveyor which carries the parts into the spray booth is a shelf designed to catch most of the waste. This shelf is coated with vaseline and covered with heavy paper which, as well as other surfaces in the booth within range of the "guns", is sprayed with a thin, even coat of warm vaseline in order to prevent the lacquer from sticking.

Twice daily the accumulation is gathered from these surfaces and taken to the laboratory, where the reclaiming is done. The mass is first put into a tumbling barrel with a proportionate amount of benzine. There it remains from 16 to 24 hours, or until the benzine has dissolved the vaseline. The mixture is drawn off and again put back into the tumbling barrel after the addition of prescribed amounts of ethyl acetate and butyl acetate. The tumbling is continued until the lacquer has been completely dissolved. The kind and quantity of thinners required to meet the needs of the different finishing materials is determined by a competent chemist. The solution is then passed through a centrifuge to remove all dirt and suspended matter, after which it is ready for re-use.

By means of this process about 400 gallons of lacquer are reclaimed monthly; and the three or four men in the laboratory have to devote only a little of their time to this compensating work.

All that remained of the once famous Hotel Cecil, in London, after the wreckers finished their job. Where this widely known cosmopolitan hostelry stood for a good many years there will shortly rise a typically modern office building for the Shell-Mex, Ltd. The work of demolishing the old structure was awarded Messrs. Trollope & Colls, Ltd., who made use of a large battery of portable compressors and an extensive array of air-driven tools and other apparatus to expedite the operation of clearing the site. The new building is after the design of Messrs. Joseph, a noted firm of London architects. Waterloo Bridge is seen in the distance at the right.

Underground Boilers Supply Motive Steam

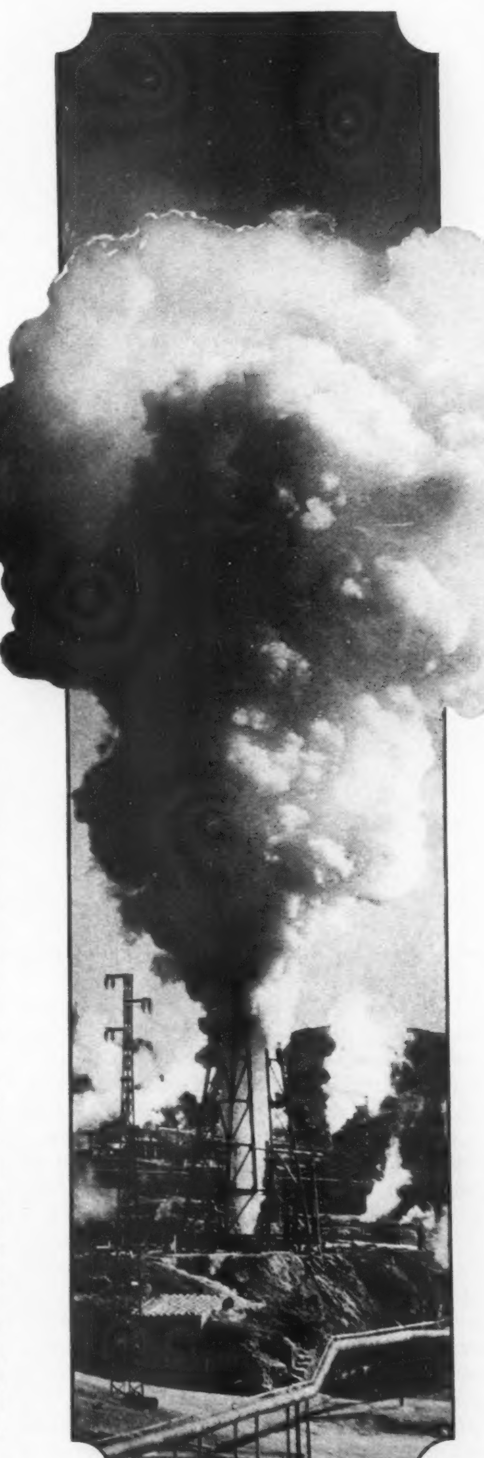
Fumaroles at Larderello in Tuscany Furnish a Large Volume of Steam Which Drives Turbines and Yields a Number of Valuable Chemicals

ITALY is making active use of large volumes of steam drawn from the bowels of the earth. The exploitation of this source of energy has been greatly stimulated in recent years; and in doing this Italy is setting an example that may be followed with profit by other countries similarly favored with geysers.

The power-using industries of Italy have long been placed at a disadvantage compared with similar undertakings in other sections of the world. Despite her resources in many directions, Italy has no natural fuels save relatively restricted supplies of wood. She has to import all her coal and fuel oil, and therefore necessity has compelled her to turn to her falling waters for electricity and to steam from underground, which is put to a number of services.

There is a section of Tuscany that is noted because of its thermal activity. It lies at the foot of a mountain range that parallels the west coast of Italy and is flanked north and south, respectively, by the Cecina and Cornia rivers. The region is distinctive because of the abundance of its hot springs and *fumaroles*—the latter being akin to the geysers of certain sections of the United States. This part of Tuscany covers an area of approximately 100 square miles; and the whole district overlies what might popularly be termed a vast subterranean boiler or series of boilers, in which much of the steam is confined until escape surfaceward is offered through deep wells drilled for that purpose. The utilizing of the underground steam has been progressively developed over a period of a century or more.

The following account of the "artificial" geysers—those created by the drilling of outlets—has been furnished by a correspondent who recently visited Larderello and the surrounding countryside. The steam issuing from the wells contains about 0.35 per cent of boric acid, a little ammonia, a small measure of carbon dioxide, and a trifling amount of methane. Water vapor constitutes 96.5 per cent of the steam, which comes out of the ground at a temperature that ranges from 320° to 375° F. Until a few years ago the steam was used only for its boric-acid content; but now it is a source of ammonia products, carbon dioxide in different forms, and, most important of all, of electrical energy that is sold to power distributors.



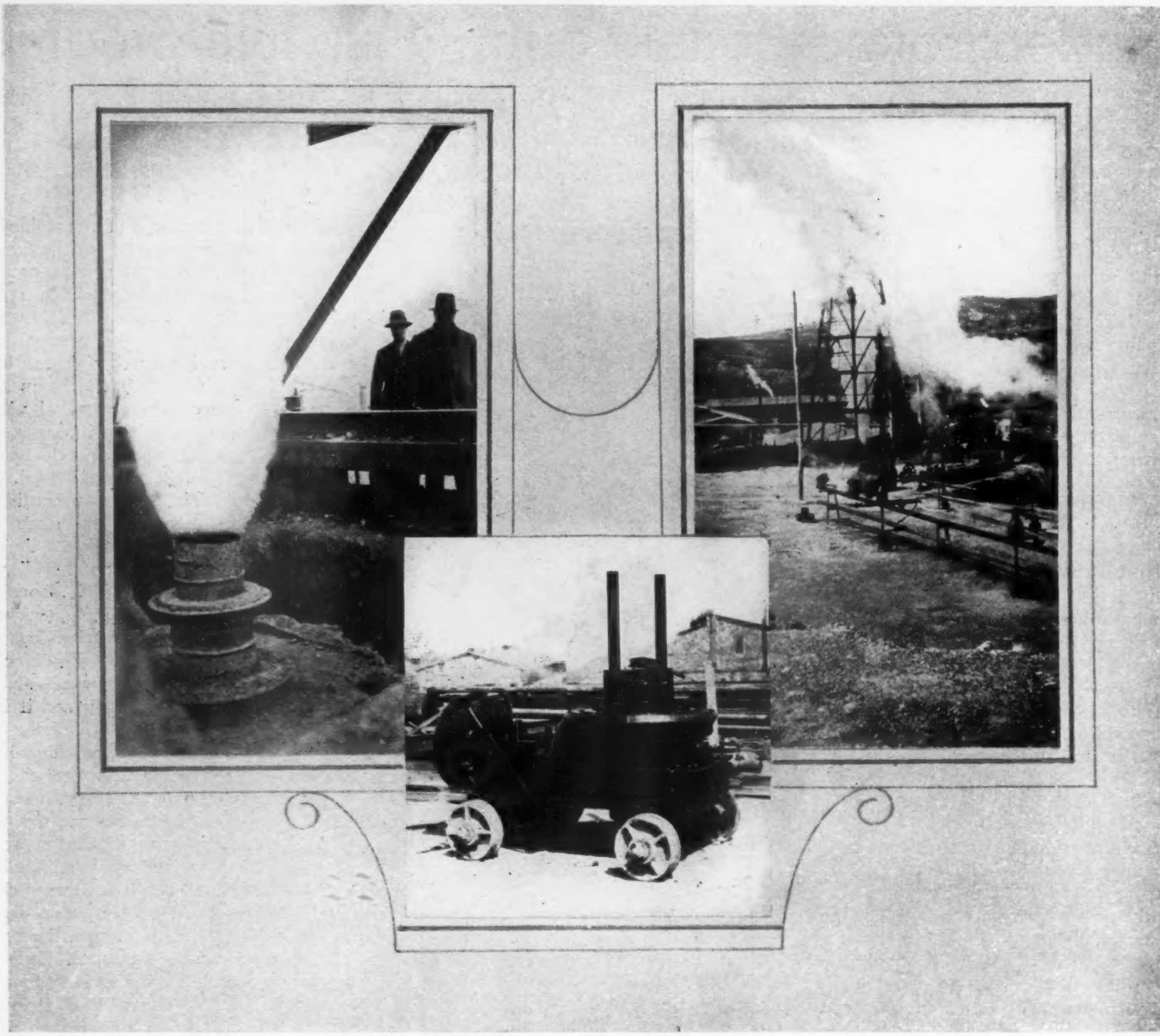
Steam well at Larderello that supplies energy to low-pressure turbines.

The steam as it comes from the wells is delivered directly to low-pressure turbines; the steam exhausted from the turbines is released into vats or tanks containing sulphuric acid; and in bubbling up through the acid the ammonia is extracted. Next the hot vapor is carried in pipes along the bottoms of evaporating ponds, and there the condensed vapors and other waters are concentrated for the recovery of boric acid. All in all, the system is a self-contained and a very efficient one.

In the earlier period of the exploitation of the region only the steam from the *fumaroles* or natural vents was used, but nowadays power-driven drills are employed to promote production. At the present time there are in the district something like twenty drilling outfits that are kept well-nigh continually at work for periods of sixteen hours a day. Because of local physical or geological conditions, a somewhat unusual drilling technique has been evolved.

The softest formation encountered is one made up of highly cemented limestone and sandstone that lies near the surface. The greatest part of the drilling, however, is through formations consisting of serpentine, diorite, chalcedony, and pure quartz. The wells are cased, and it is customary to drill holes to a depth of approximately 330 feet and large enough to accommodate 15-inch casings. These casings are thoroughly cemented, from top to bottom, to the formation penetrated. From that depth downward drilling is continued—the hole being of a diameter to take a 10-inch casing. When the hole has reached certain well-determined markers in the formation, the casing is landed and cemented. The 10-inch pipe is solidly cemented from top to bottom not only to the formation but to the lower end of the 15-inch casing. The depth to which these wells are sunk varies from 600 feet to 1,500 feet, and is determined by the topography of the surface and the distance of the location from the plane of the fault line along which the steam is found.

As might be expected, in doing work of this kind, all sorts of drilling apparatus have been tried; and, after wide experience, the operators have virtually standardized on two types of machines—one being of the core-drill type and the other of the rod percussion type. Core drilling is preferred because it can be done faster. A core drill is easier to handle and gives but little trouble. Percussion drills are used to do the final drilling, although they are very slow and give considerable trouble when penetrating hard formations. The reason for utilizing the percussion drills at all is that when steam is struck the circulating water is ejected from the hole, and so is the barrel of the core drill. This is understandable because the core barrel, which occupies nearly the full section of the hole, acts as a piston and is blown like a straw out of the hole by the released steam. The same objection holds against the employment of cable tools. With



Left—Close-up of a steam well in the Larderello district. Right—The well surmounted by a derrick produces about 463,000 pounds of steam per hour. Bottom—One type of core drill used in tapping subterranean sources of steam.

the rod system of drilling, on the other hand, the tools can be held down and the well kept under control at the same time.

No effort is made to shut in the wells so as to hold them in check when drawing steam from them. The steam is permitted to flow unchecked right to the turbines, where the pressure will va y anywhere from $1\frac{1}{2}$ to $2\frac{1}{2}$ atmospheres. Assuming that the shut-in pressure is that normal for steam at a definite temperature—in this case the temperature is around 302° F., then the shut-in pressure would be about 5 atmospheres. While this pressure is not very great, as pressures go in the latest of steam plants, still a well at that pressure, venting directly into the atmosphere, will make a racket that renders conversation impossible within a radius of a quarter of a mile. One's ears are deadened for a day or two afterwards when subjected to that din.

What has been done in the neighborhood of Larderello in the utilization of subterranean sources of steam is suggestive of what may yet be done in the United States. For example, in Alexander Valley, about 100 miles north of San Francisco, efforts to this end were initiated nine years ago when the first well was drilled to a depth of 203 feet. That well gave steam at a pressure of 62 pounds. Two years later, two other wells were drilled. Two of those early wells lie but 48 feet apart, and there is a difference of pressure of only 2 pounds in the steam coming from them. The singular thing is that the free release of steam from one well in no wise lowers the pressure in the neighboring well; and when steam has been permitted to escape unchecked for months, the well pressure is soon restored to its erstwhile maximum shortly after the throttle is closed.

The foregoing facts give warrant for the belief that the supply of steam underground is inexhaustible, and that the neighboring wells are not directly interconnected and are, apparently, akin to vertical steam domes or superheaters surmounting a boiler of unknown magnitude. It has been estimated that 1,000 wells could be drilled in the Alexander Valley without reducing the original steam pressure in the least; and, according to some figures, anywhere from 50,000 to 100,000 kw. could be generated from the steam.

RUBBER PAVING AROUND ST. PAUL'S

A SPECIAL committee has been appointed by the London City Corporation to consider the advisability of paving the whole of the roadway around St. Paul's Cathedral with rubber not primarily for the sake of lessening noise but to reduce vibration, which is endangering the stability of the famous edifice. It will be recalled that that house of worship was but lately closed to the public for many months while undergoing extensive restoration.

Rubber has already been used in London to pave streets; and that material is said to have stood up exceptionally well under heavy traffic. As a matter of fact, rubber blocks laid in 1870 are still in service. At the present market price, rubber would cost about ten shillings—roughly, \$2.50—more per square yard than granite.

Submarine drills have been used extensively in clearing the channel between the Battery and Governors Island in New York Harbor.

Progress in Drilling Subaqueous Rock

PART II

By CHARLES C. HANSEN

IN BUILDING the Ocean Terminal at Halifax, N. S., for the Canadian Government in 1915, considerable rock-dredging was required. Two well-drill boats were constructed by the contractors—one with ten and the other with seven well drills. The drills were not movable, but were placed in fixed positions spaced about 10 feet between centers on one side of the vessel. The drill stem and bit were made to work in a casing pipe that could be lowered to rock; and the overburden was pumped out with a bailer before drilling was started. Each drill was operated by a steam engine, with the same arrangement of drilling tools, spudding crank, hoisting drum, and ropes that had been used on blast-hole drills on land work. The drill holes were in some places quite 80 feet deep because the rock was so porous that it was not a safe support for pier walls. One of these boats was moved to New York Harbor in 1925, and another of the same general type was built. To reduce operating costs, two Diesel oil engines, connected to electric generators, supplied the power for handling all machinery.

In soft or medium-hard rock, such as is found in the water bed about a quarter of a mile above Hell Gate Bridge in the East River, each of the seven drills was able to put down a hole about 8 feet deep in approximately eight hours. The general arrangement of anchor spuds and spring lines for holding the Great Lakes drill boats of the same date in position when drilling was adopted for these Atlantic Coast vessels. The casing pipes, in which the drills worked, were made to telescope; and they were similar to those used on Black Tom Reef, in 1881, for casing off the overburden. This system lends itself to deep drilling, because the depth of water alone determines the length of the casing pipe and of the rope on the spudding drum. Of course, drilling is somewhat slow, because the drill can make but 40 to 50 blows per minute. Depending as it does on the weight of the tool and its drop by gravity for penetration, progress is exceedingly slow in hard rock. Drilling in this manner has, therefore, only a limited application.

Long before submarine drilling reached the status last mentioned, hammer drills had supplanted piston drills on land. The lighter weight, the faster drilling speed, and the greater ease of handling compelled this change on economical grounds. The fact that cuttings could be blown out of a hole with compressed air by using hollow drill steel, or washed out with water in wet ground, helped materially in hastening this advance. Hollow drill steels were perfected; and forging machines for making bits and shanks helped further in this notable progress. By the time these improvements were achieved, compressed air was well-nigh universally employed to drive hammer drills.

With the foregoing facilities available, it was quite natural to try them out for submarine drilling. This was done; and, first, standard hand-held "Jackhamers" were operated from rafts or barges in much the same way that piston drills were employed in the early stages of submarine drilling. In removing restricted areas of rock, divers would take "Jackhamers" down, drill holes, and then load them with explosives. When the divers had returned to the boat, the charges were detonated. At best, this was a slow and rather expensive operation, and could not be employed in drilling large areas of rock underwater.

The next step forward in submarine drilling was the experimental use of the large hammer drill, which was mounted in much the same way that the piston drill had been mounted on boats on the Great Lakes; but there, again, long steels were objectionable and a handicap. In shallow water, and when short steels will answer, these drills may be found serviceable within a limited field. What the contractor was looking for was a true submarine hammer drill—one that would meet all conditions of rock and depths of water and give the same increased drilling speed submerged that the type had made possible when attacking rock on land.

A submarine hammer drill capable of satisfying all requirements was designed in 1926, and several plants so equipped were operating in 1927. The boat favored on the Great Lakes, with drill towers traveling along

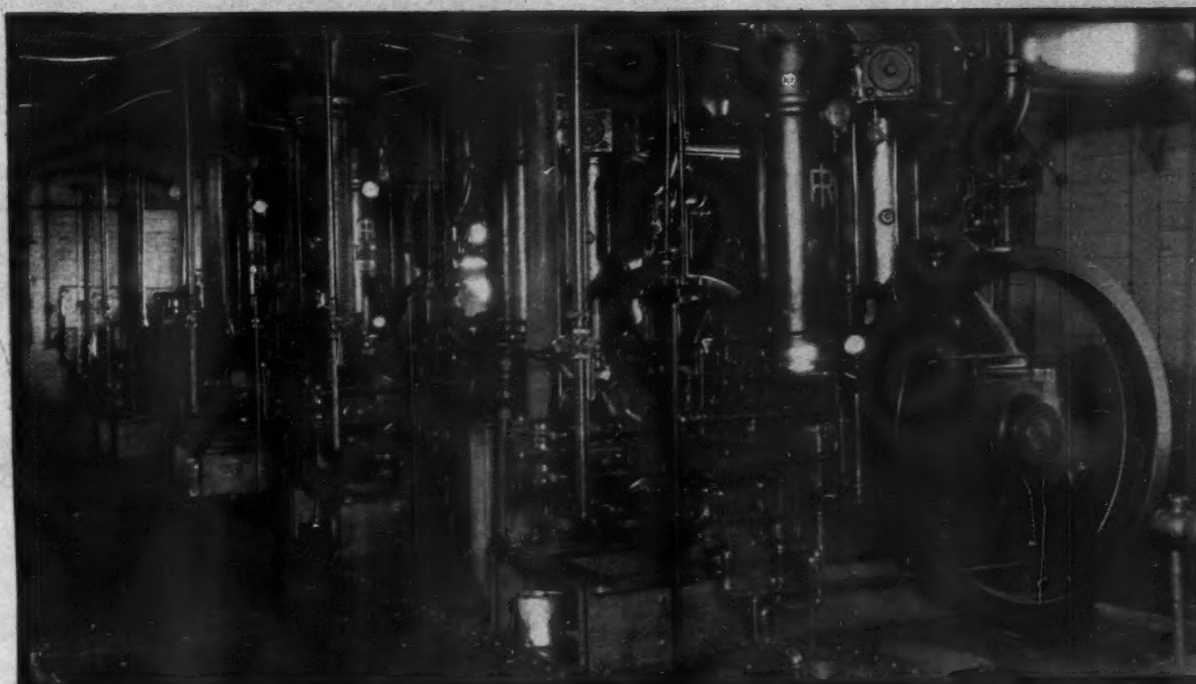
Top—Drill boat equipped with three X-71 submarine drifters mounted at one end of the craft. Bottom—Drill boat and mucking barges at work in Beverly Harbor, Mass.

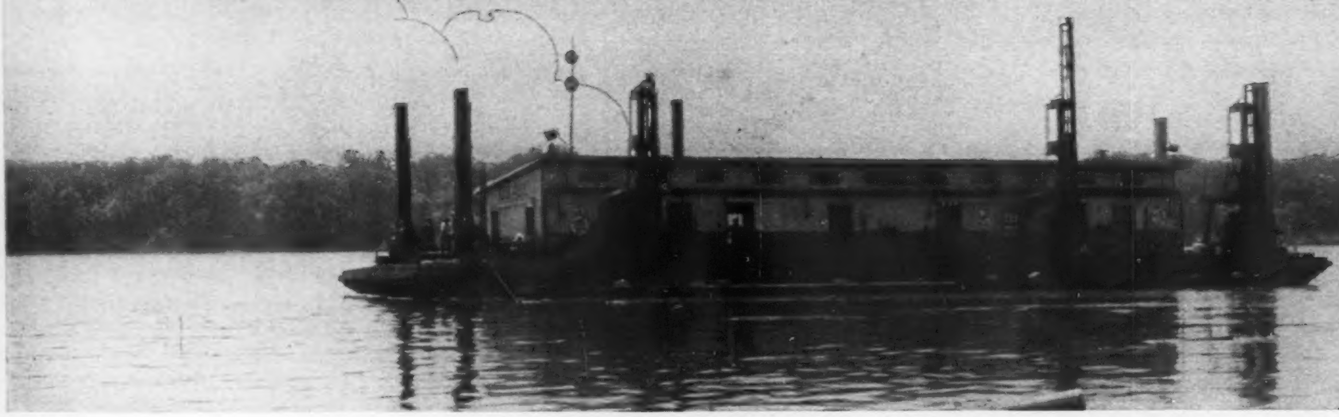
one side, was generally retained, as well as four anchor spuds—each of which had its own engine for quick operation. For otherwise mooring and moving the boat in position for drilling and for shifting before blasting, spring lines were depended upon. Unquestionably more attention should be given to facilities for moving a boat as well as for loading drill holes, because time spent otherwise than in drilling rock is unproductive.

The new drill is a valveless type of large dimensions. The piston weighs about 28 pounds, and it strikes between 1,500 and 1,800 blows a minute. In front of the cylinder is a chuck, for 1½-inch hollow steel, which is geared to a pinion shaft that extends upward alongside the drill cylinder. The chuck is of the bayonet-lock type for lugged steel, with removable driving keys. Below the chuck is a bell-shaped extension that acts as a diving bell to keep the water out of the drill. All exhaust air from this drill enters the bell and escapes from under its bottom edges. Within the bell are two safety catches or hinged gates for the steel, in case the steel should spring out of the bayonet lock. These gates are connected by links to a beam above the cylinder; and they can be opened with a wire-rope trip extending the length of the frame or ladder. The air bell is the only means used to keep the water out of the drill. Air and water connections are at the top of the drill cylinder; and water is supplied at a pressure of 200 pounds to wash cuttings out of drill holes. The water, fed by a tube fastened in the back head, passes through a hole in the piston and enters a hole in the drill-steel shank, as in the case of land drifters.

The drill cylinder, with chuck and air bell, is bolted to the lower end of a structural-steel frame, familiarly called the "drill ladder", with grooves for guiding it in the drill derrick or in drill spuds. The ladder is made about 6 to 8 feet longer than the deepest water in which drilling is to be done. On top of the drill ladder is bolted a small rotating engine, which is geared down to the desired speed. The engine is connected to the pinion shaft in the chuck by means of hollow-steel rods in 10-foot lengths screwed together with couplings. Each length of hollow steel is guided by two bearings bolted to cross pieces in the drill ladder.

The drill ladder, with drill and rotating engine, may be mounted in two ways. For shallow drilling, where there is a trifling current, the drill ladder is guided in a drill derrick and handled vertically with wire rope and hoist. To seal off overburden from a drill hole it is the practice to use a short sand pipe that is long enough, however, to extend above the overburden. This pipe is fastened in a heavy cast crosshead that terminates above the pipe in a large funnel so as to make it easier to find the pipe with the drill steel and to load the hole that has been drilled. To the two arms of the crosshead are clamped two pairs of telescoping pipes. These are far enough apart to let the drill and the ladder





Top—Oil-engine-driven compressors on board United State Army drill boat "No. 426" after alterations. Bottom—"No. 426" in service on the Mississippi near Rock Island, Ill.

pass all the way down to the funnel; and these pipes are guided in the derrick and raised and lowered by means of a wire rope and a small hoist.

In deep water, with tidal currents and wave action, a drill spud or "drill column" gives better results; and when this construction is used the drill ladder is guided entirely in the drill column. The bottom end of the drill column terminates in a heavy sand pipe on which the column rests. Drill columns are handled by wire rope and hoists located on the derrick floor. The derricks are of structural steel and similar to those on the Great Lakes boats. The derricks are shifted along the deck, on rails, by a hydraulic cylinder and endless chain, which can handle them all and in either direction. This is done by hooking the derricks on to the chain and by moving the hydraulic in the direction desired.

It should be evident that a drill ladder and a drill extending down into the water will reduce, accordingly, the length of steel used. In New York Harbor, for instance, in 1925, it was decided that a certain channel should be 42 feet deep at low water. The old channel was about 36 feet deep. The difference between high and low water is approximately 7 feet. In all submarine drilling it has been found best to drill the bottom of the hole from 6 to 10 feet below grade so as to leave no high spots after blasting. The contracts usually allow pay for dredging 2 feet below grade.

Work of this sort when done with piston drills would require a steel from 60 to 65 feet long; and as such steel is made from material about 2¼ inches in diameter it would weigh from 810 to 870 pounds. With the submarine hammer drill, on the other hand, a steel of from 20 to 24 feet in length—including the sand pipe—would suffice to drill to the same depth below grade. This steel, 1½ inches in diameter with a ½-inch hole in the center, would weigh between 110 and 140 pounds. This shows a notable reduction in steel requirements, and is a means of saving much time in handling and in changing steels. Two men can operate the drill and do the needful changing, unassisted, in less than five minutes. The use of lighter and shorter steels has simplified the work of sharpening them.

The process of drilling is substantially like that followed in the case of piston drills on Great Lakes drill boats. After anchoring a boat with the spring lines and anchor spuds, the sand pipe, on telescopic leads or on a drill column, is lowered to the water bed. The drill and the ladder, with steel in chuck, are lowered. The water valve is opened so that a stream is issuing from the hole in the drill bit. When entering the sand pipe, rotation is started, and the mud or overburden is washed out of the pipe as it settles on to the underlying rock. The drill hole is begun in the usual way by letting the piston strike the steel lightly until the rock is penetrated a few inches, after which full air is admitted

to the drill cylinder.

The rotating engine, mounted on top of the ladder and with its shaft extending down the ladder to the drill chuck, turns the steel during drilling. The number of revolutions a minute is under the control of the drill runner. The action or speed of the shaft gives the operator a visible guide in feeding the drill. The speed of the shaft indicates to the runner whether he be feeding too fast or too slowly, and it also telegraphs him when any obstructions, seams, or pockets are encountered. He can manipulate the valves controlling the air to his drill and the speed of the rotating engine, and he can lift or lower the drill ladder, as experience has taught him, to overcome trouble.

The back pressure on the drill piston, due to exhausting underwater, does not seriously affect the drilling speed. When a drill is working in 30 feet of water, for example, the back pressure on the exhaust is less than 15 pounds; and this can be counteracted by a slightly higher air pressure. The compressor plant furnishes air up to 100 pounds pressure; and the rated drill speed is based on air at a pressure of from 80 to 85 pounds. The operator can control the speed and the power at will; and the valveless construction of the drill is admirably suited to make it responsive to changes in air pressure or to variations in back pressure on the exhaust. This will range from nothing when running above water to the pressure at any submergence; and the drilling speed can be maintained by suitable changes in the air supply. All necessary controls can be handled from the derrick platform; and a drill runner and a helper can do everything required in operating a drill.

In 1927, the United States Army drill boat on the Mississippi River was altered to carry hammer drills operated with compressed air. The drill derricks were modified to take hammer drills and ladders; and three such drills were installed. The boiler plant was removed; the craft was equipped with four oil-engine compressors; and all hoists and other machinery previously driven with steam were made to operate by compressed air. For some time after the refitting of that drill boat she was used on small "patch" drilling that required only shallow holes. That work necessitated the frequent moving of the drill boat; and, because of the nature of her employment, it was not possible to arrive at an accurate comparison between steam- and air-operated drills. However, Mr. A. L. Richards, Associate Engineer, at Rock Island, Ill., made this statement in an article prepared by him and published in the January, 1929, issue of *Compressed Air Magazine:* "It may be positively stated that the air-driven X-80 drills will put down a hole at the rate of 1 foot per minute, while the old drills took five minutes to put a hole down to a depth of 1 foot."

Recently, Mr. Richards has amplified his earlier evaluation of the air-driven outfit in the following manner: "No delays caused in refueling, as the oil simply runs into the supply tank, while with coal it was a matter of several hours delay in the drilling while the crew 'coaled up'.

The oil-air outfit is much cleaner than the coal-steam plant, and it is more dependable, causing less repairs, replacements, and costly delays than the former installation.

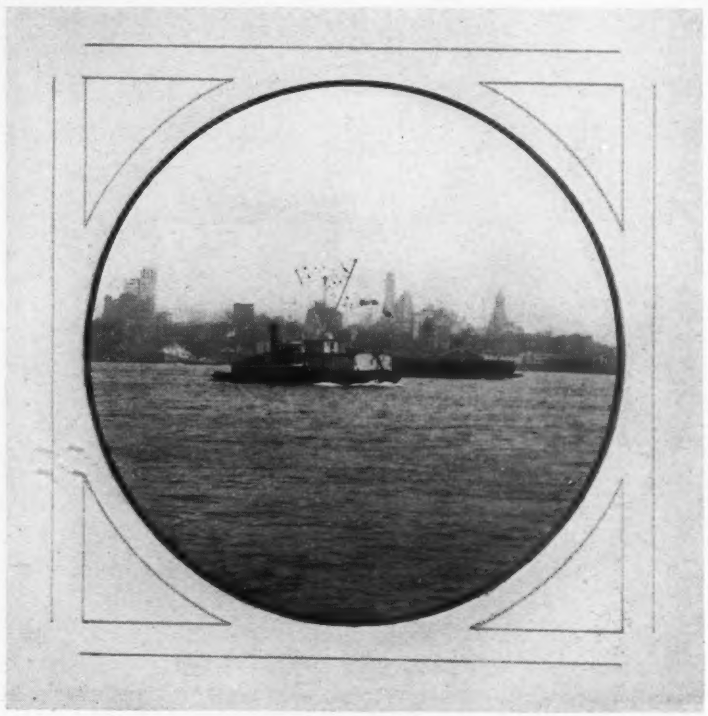
No steam pipes to freeze up and burst during cold weather.

No hot steam condensation squirting out when drills are started, causing everyone to get out of the way or get scalded.

All supply pipes with air are always cool enough to handle, and no attention is given to the air exhaust from these pipes.

All the employees much prefer the air, and they render much more efficient service than when working with steam.

Incidentally, the new oil burner drill furnace, worked in connection with the No. 50 sharpener, gives a much better cutting bit than the old coal forge heater, and it is believed this method of heating the steel has added to the life of the steel, as much less breakage appears to occur."



The submarine rock drill has done much in deepening the busy East River.

As Mr. Richards has previously pointed out, apart from the foregoing gains, the major reason for the choice of the oil-engine compressor is an economic one. Just as drilling costs are lowered by the use of air-operated drills instead of steam drills, so does the substitution of the oil engine insure savings that are not practicable when steam is employed.

Early in 1927, a churn-drill boat in service in New York Harbor was changed over to use hammer drills, as just described. The seven churn drills were removed and three hammer drills substituted; and a compound steam-driven compressor, drawing steam from an old boiler, supplied air to the drills. This drill boat has worked in different sections of the harbor continuously for three shifts daily during the last two years. The only pauses have been due to fogs, when ranges could not be seen and the boat could not be placed exactly where drilling was desired. In hard rock, the three hammer drills have produced in a given interval more than 40 times the quantity of blasted rock obtainable when drilling and blasting with the seven churn drills.

Submarine hammer drills are now being tried out on the Great Lakes and the Panama Canal, but they have not been in use long enough to furnish any reliable data. However, it appears to be safe to expect about fourfold as much drilling as with the steam piston drills; but time alone will determine whether or not this type of machine will be universally successful in all classes of subaqueous rock drilling. The hammer drill, because of its increased drilling speed and its lowering of costs generally, has displaced piston drills for nearly all land drilling; and for the same reasons it should prove superior in drilling rock underwater.

FACING MATERIALS FOR INGOT MOLDS

EXPERIMENTS in the spray-coating of ingot molds before pouring the molten metal so as to improve the quality of the steel have been dealt with in *Stahl & Eisen*, which brings out the following interesting facts. The object of the facing is, of course, to prevent the adhesion of oxide crusts to the walls of molds, because such crusts, if embedded in an ingot, will produce blow holes, poor internal welds, and inclusions.

Graphite and bitumen were found suitable in the case of top-cast ingots, but they did not check the formation of an oxide crust on the surface of metal poured slowly in a bottom-cast mold of large diameter. A facing of powdered aluminum obviated adhesion because of the heat induced by the reaction of the aluminum to the molten steel. Substances that give off reducing gases served to keep out oxygen and to that extent lessened the amount of heat absorbed by the mold. Water-free tar and rapid-drying asphalt lacquer gave the best results, especially when they were mixed with aluminum powder. If too thick a coating was sprayed on the walls the surface was poor owing to gas bubbles. Coking of the tar facing was also the cause of rough surfaces and led to the adhesion of crusts. Therefore, any tar used for this purpose should be stable at 200° F. to prevent its charring when applied to warm molds.

Baltimore & Ohio Railroad bridges across the Potomac at picturesque Harper's Ferry. The newest bridge, at the extreme left, was opened for service a few months ago.

Harper's Ferry Place of Many Bridges

HARPER'S Ferry is inseparably associated with the name of John Brown, the picturesque and notorious abolitionist. That quaint old town where the states of Virginia, West Virginia, and Maryland meet, and where the Shenandoah flows into the Potomac, has another claim to distinction—it is one of the most bridged sites in the United States. The recent completion and putting in service there by the Baltimore & Ohio Railroad of a new bridge adds one more chapter to a story that goes back perhaps a century or more.

In 1834, when the Baltimore & Ohio reached Harper's Ferry, there was already across the Potomac a 2-lane wooden highway bridge. This covered structure was replaced by another wooden one built by the railroad to take care of its traffic as well as highway traffic. The second span was finished in 1836, and was the longest railroad bridge constructed in the United States up to that time.

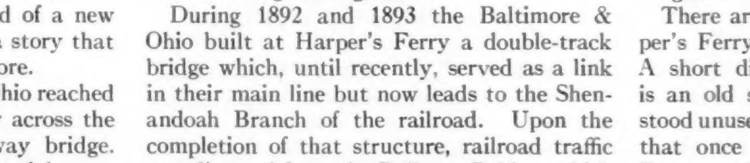
Fifteen years later, after several collapses of portions of the latter structure, work was started on what is known today as the Bollman Bridge. It was designed by Wendall Bollman, then roadmaster of the Baltimore & Ohio, and was one of the earliest American bridges in which iron was used exclusively. Before its completion, in 1869, the structure was almost totally destroyed several times by floods and by the Federal and the Confederate armies. The "taking" of the Bollman Bridge was the first step in the famous John Brown drama at Harper's Ferry. Brown and his "army" held it during the first night of the tragic episode and into the next day; and the first man killed in that raid of October, 1859, was shot on the bridge.

As it is today, the Bollman Bridge is one of the most picturesque in America. The old spans that remain are as different from prevailing types as locomotives of today are from those of the "sixties". Originally it consisted of six spans, and was considered in its time a structure of remarkable strength and a marvel of engineering skill.

During 1892 and 1893 the Baltimore & Ohio built at Harper's Ferry a double-track bridge which, until recently, served as a link in their main line but now leads to the Shenandoah Branch of the railroad. Upon the completion of that structure, railroad traffic was diverted from the Bollman Bridge, which has since then been used to carry highway traffic between West Virginia and Maryland. Seven years ago two spans of the historic bridge were swept away by a flood. These were replaced by through truss spans.

Last October work was started on the newest Baltimore & Ohio bridge at that point. After serious damage by fire when almost finished, it was finally put in service during June of this year. It is composed of fourteen double-track deck-plate girder spans; permits better alignment of the railroad through Harper's Ferry; and is of heavy enough construction to meet future increases in the weight of motive power.

There are other bridges of interest at Harper's Ferry besides those over the Potomac. A short distance from the railroad station is an old spider-web-like structure that has stood unused for 40 years. It spans the "canal" that once conveyed water from above the Potomac dam down to the old Government arsenal, and it also served as a link in the Baltimore & Ohio system. That ancient rusty span remains today as a lonely vestige of the great days of Harper's Ferry. When water ran through the canal to develop power for the great Government works, Harper's Ferry was one of the busiest manufacturing towns in the United States. The vehicular bridge across the Shenandoah, one end of which is only a few feet from the western terminal of the Bollman Bridge, completes the list. This structure is a railroad bridge that is not a railroad bridge: a sort of believe it or not affair. With the exception of the floor, it is built of old rails—the top and bottom truss chords and the diagonal and vertical web members all consisting of double lines of rails.



Historic Bollman Bridge, at the right, with the double-track bridge which supplanted it seen at the left.

Eighty-four per cent of the rubber used in the United States goes into the manufacture of tires.

West portal of tunnel through First Mountain.

Mountain Pierced in Driving Long Sewer Tunnel

By Recourse to Modern Mining Methods This New Jersey Project was Advanced Rapidly

By S. G. ROBERTS

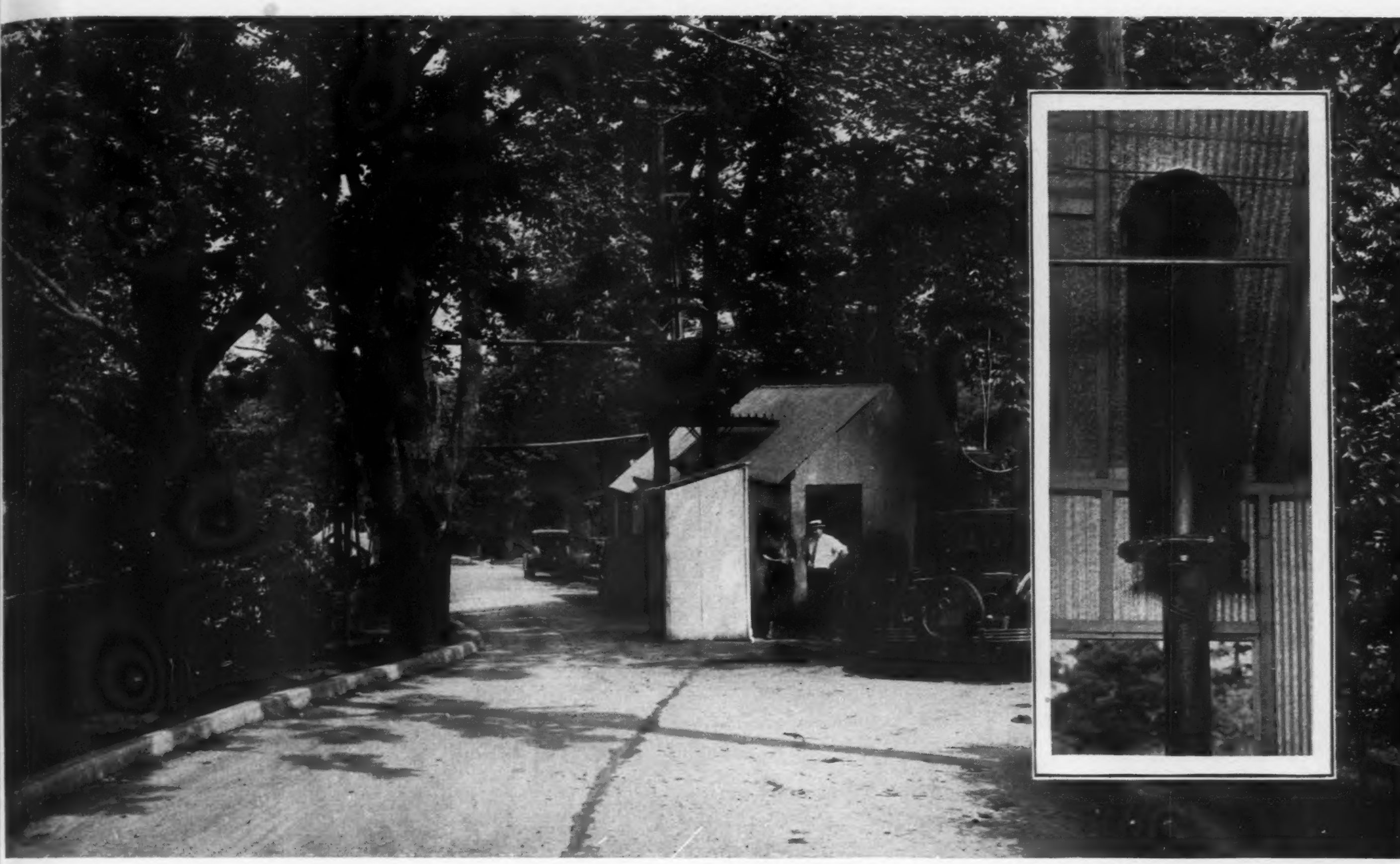
WORK now in hand in West Orange, N. J., exemplifies in a striking manner what can be achieved through coöperation. West Orange is one of numerous communities in Essex and Union counties—outlying the municipalities of Newark and Elizabeth—that have interrelated or reciprocal interests. One of these vital interests is that concerning sewage disposal, because sooner or later the discharge from the several communities must converge toward a common body of water.

For a goodly number of years, certain of these towns or townships made use of the nearest river or lesser stream to move the sewage seaward—giving little heed the while to the effects upon the health or comforts of communities situated below and beyond them. This was not so serious in the beginning, but it became so when their populations increased and the volume of the contaminating effluent attained menacing proportions. The situation then emphasized how much for the common good could be gained by the interested communities getting together and sharing in the construction of a joint outlet sewer. As a consequence, the project agreed upon will serve either in full or in part populous sections of the two counties mentioned. West Orange is one of the sections that will be benefited; and it is with operations now in hand there to this end that this article deals.

West Orange is bisected north and south by First Mountain. The more thickly settled part of the town lies on the east side of the mountain and in the valley below. The west slope and adjacent territory is rather sparsely built up at present, and this area dips toward a valley in which there is a reservoir or lake that furnishes water to the Village of South Orange. Many of the homes in this division of West Orange discharge their sewage into cesspools; and there are numerous sound hygienic reasons for abandoning such a system of disposal. A sewer tunnel has been driven east and west through First Mountain, and this will provide an outlet for the western area which unquestionably will be intensively developed for residential purposes before long. The tunnel on the east side of the hill will be linked with an existing trunk sewer system that is an integral part of the intercommunity outlet.

From end to end, the tunnel, which was holed through on August 29, is 6,830 feet long. It was driven from two portals at the east and the west ends, respectively, of the project. Inasmuch as the geological formation pierced is not a uniform one, the problem differed somewhat at each of the opposed headings. For three-fifths of the way through the mountain the heading driven from the west portal was in very hard traprock, while the heading advanced from the east portal was entirely in sandstone or red shale that was easy to drill. The traprock stood up generally very well; and it was necessary to timber but 12 to 14 feet of this section and to concrete only 12 feet of it. In the soft-rock section, on the other hand, quite 150 linear feet of the tunnel had to be timbered. Where the traprock and the soft rock meet, in the western section of the tunnel, the shale is extensively faulted; and for that reason, besides adding to the tunnel driver's difficulties, it provided a ready outlet for water carried above in the ground. This water proved very troublesome, inasmuch as the tunnel gradient dips from west to east, and sorely taxed the installed drainage equipment. Where the tunnel passes beneath the crest of the mountain, the superposed ground has a vertical thickness of 300 feet.

The cross section in traprock is 5x7 feet in the clear, and the roof is arched on a radius

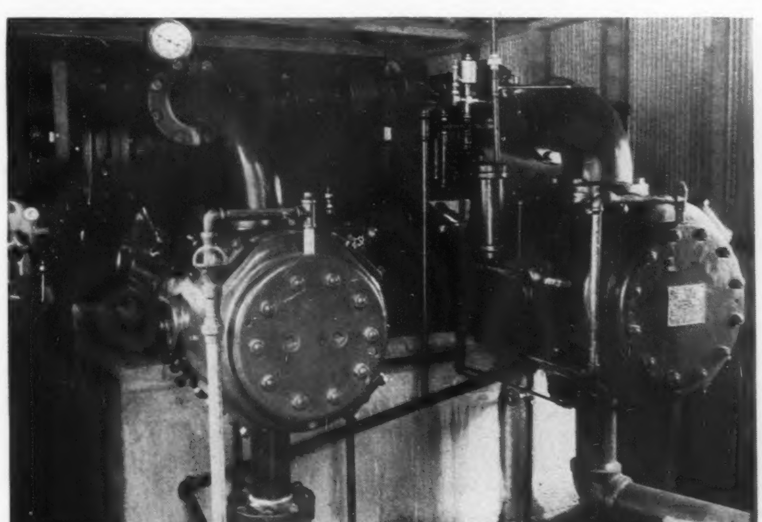


Compressor plant at east portal which was erected partly on a highway in the midst of an attractive residential section. Insert shows the Maxim silencer that was fitted to the compressor.

of 2½ feet. The cross section in red shale is 5x6½ feet. The western section, where in traprock, called for a drill round of from 18 to 24 holes, while a round in soft rock consisted of 18 holes 6 feet in depth. The drill holes in hard rock were driven to depths of 8 and 10 feet. The practice was to use what is known as a "Burns cut"—that is, to drill three 3¾-inch holes, 10 feet deep, in the center of the face. These holes are not loaded, and they serve to direct the movement of the rock centerward at the time of firing the loaded holes. In hard rock, 65 pounds of 60 per cent gelatine was used for each round, while 40 pounds of 60 per cent gelatine was employed in soft rock.

Because speed of execution is a factor in the contract, the superintendent, Mr. C. C. Freeman, adopted a rather uncommon set-up for his drills at each heading. Owing to the narrowness of the tunnel, he found it expedient to utilize a single column, with two arms, at each heading; and this equipment, as shown by one of our illustrations, permitted the mounting of three Ingersoll-Rand N-75 drifters so that each drill runner had a satisfactory measure of unhampered control. A drilling crew was made up of three drill runners, three backers, a nipper, and a foreman. In the course of six days, at the west heading, an advance of 146½ feet was made in traprock; and at the east heading, in a similar interval, an advance of 162 feet was accomplished through shale. An average of 68 men was employed on the job at both ends of the tunnel, and these worked continuously in three shifts once operations were in full swing.

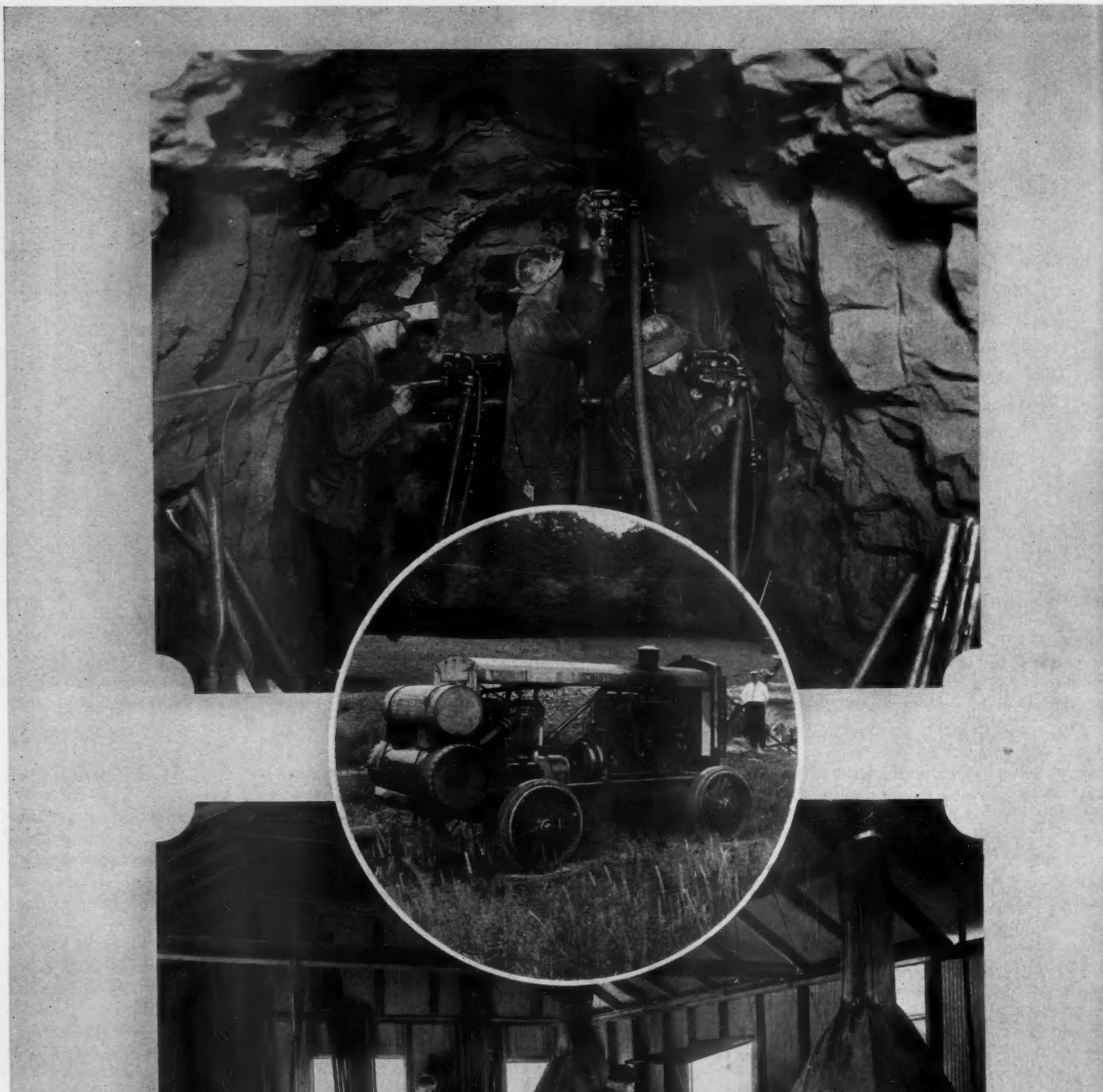
The tunnel slopes from west to east on a gradient of 1.2 per cent. In the western section drainage was effected by pump, and the loaded muck cars had to climb to reach the portal. On the east side, on the contrary, drainage was downhill and by ditch; and the disposal of muck was likewise easier. Mucking was done in each section by an air-driven, drag-line scraper loader. Cars of 1½ yards capacity, hauled by storage-battery locomotives, handle the muck. The use of side track and switches was obviated at the headings by utilizing car shifters popularly called "cherry pickers". A cherry picker consists of an arm, carrying two grab hooks, suspended from a 1-ton chain hoist which, in its turn, is pendant from a trolley that moves transversely on a 4-inch I-beam supported in recesses drilled overhead in each side of the tunnel.



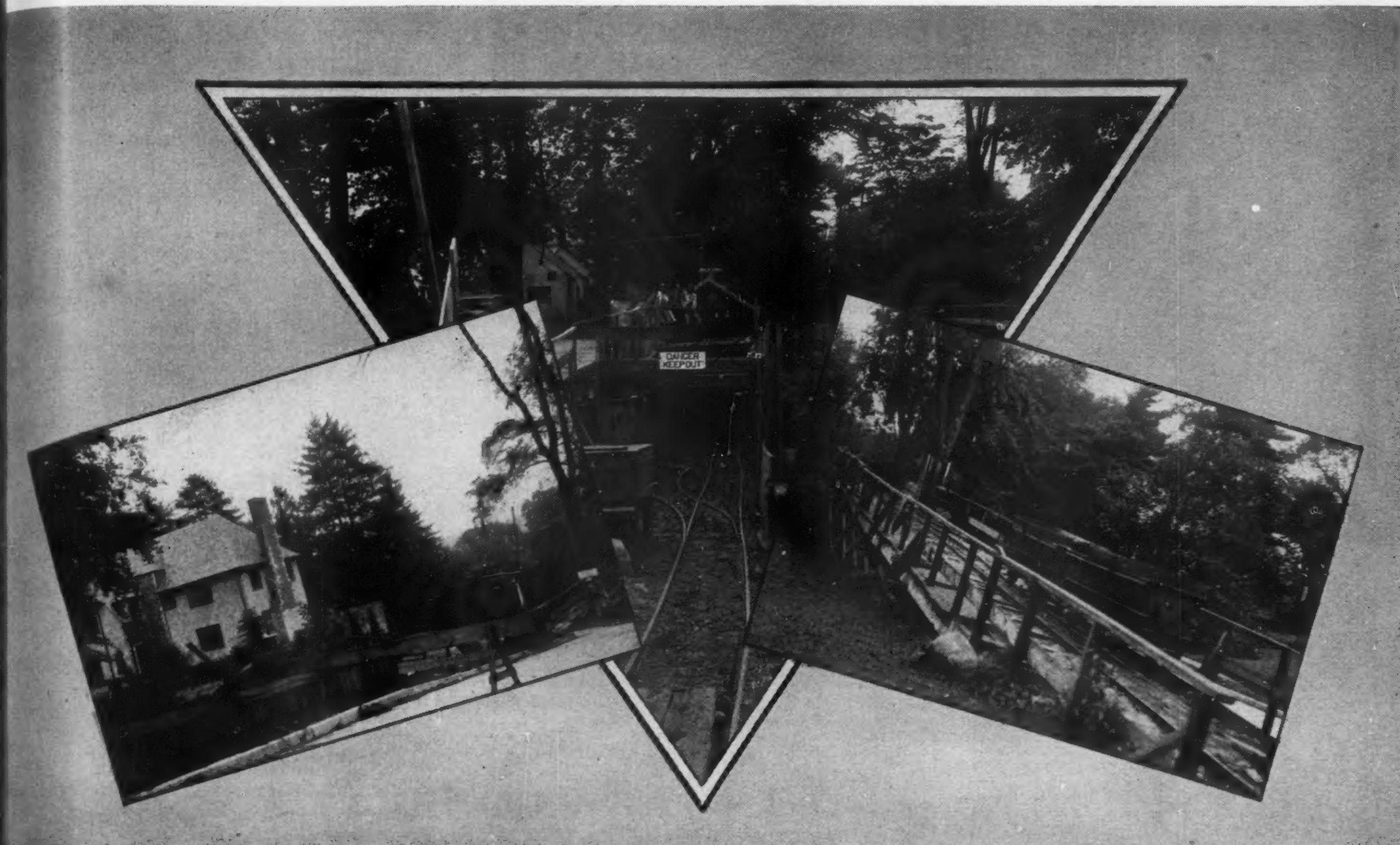
This XRB compressor, equipped with a Type VC aftercooler, furnished air at the east portal of the tunnel.

The tunnel sections were ventilated by blowers moving the air through 8-inch piping. This system was supplemented by drill holes, 10 inches in diameter, which were driven from the surface primarily as a means of facilitating the alignment of the tunnel and of determining the character of the rock through which the tunnel was driven. These drill holes also served as conduits through which electric cables for lighting the tunnel sections could be conveniently led.

Owing to the fact that the eastern section of the tunnel passes through a highly developed residential section of West Orange, the contractor



Top—Mounting used effectively for three N-75 drifters in driving the First Mountain tunnel at a rapid rate. Circle—Portable compressor employed in the preliminary stages of work at the west portal. Bottom—This well-equipped blacksmith shop at the west portal conditioned all the steels used at both headings.



East portal of First Mountain tunnel. Smaller pictures show, respectively, a typical nearby residence and the trestle over which muck cars were run to the truck-loading chute.

was slowed up in the earlier months of his work because he was able to employ only one shift so that there would be no drilling and blasting during the rest of the 24 hours. Subsequently, as the tunnel got farther underground, it was possible for him to resort to three shifts and to keep the work going night and day. However, care had to be continually exercised to reduce noise and the shock of firing as far as practicable. The drill holes in the east heading, in shale, were put down to an average depth of only 6 feet; and less powerful charges of explosive had to be used to shatter the rock. This, of course, lessened the speed of advance.

Besides the N-75 drifters already mentioned, the contractor employed an X-71 drifter, an S-49 "Jackhamer" stoper, a number of "Jackhamers", and several CC-45 paving breakers. The paving breakers were used to drive sheet piling in the open cuts leading to the two portals. A blacksmith shop near the west portal reconditioned all the drill steels used on the job at both portals. The shop was called upon to handle something like 800 steels daily. The shop was equipped with two Ingersoll-Rand sharpeners—one a No. 34 and the other a No. 50 machine; with two oil furnaces—a No. 6-F and a No. 26; and with a No. 8 pedestal grinder. The drifters were fitted with 1¼-inch and 1½-inch hollow round I-R steel, and the "Jackhamers" with 1-inch hexagonal steel. Sharpening was done by one crew working one shift daily.

A compressor plant was installed adjacent to each portal. At the west portal was an XCB machine of 9¼&15x12 inches and also an 8x10-inch Type 20 portable: at the east portal an XRB machine of 8&13½x10 inches supplied the needful compressed air. Both stationary units were equipped with I-R aftercoolers and Maxim silencers. The silencers answered admirably in reducing noise that might have been objected to by neighboring residents.

The tunnel was driven by Antonio DiMarco, general contractor of White Plains, N. Y. Work on the project was started at the west end on January 8 of the current year; and, according to the contract, the tunnel should be completed within ten months from the beginning of operations. In addition to driving and lining the tunnel, the contract calls for the laying of 16-inch cast-iron pipe. Eventually, telephone and power cables are also to be run through the tunnel. The total cost of the undertaking will be $268,000.

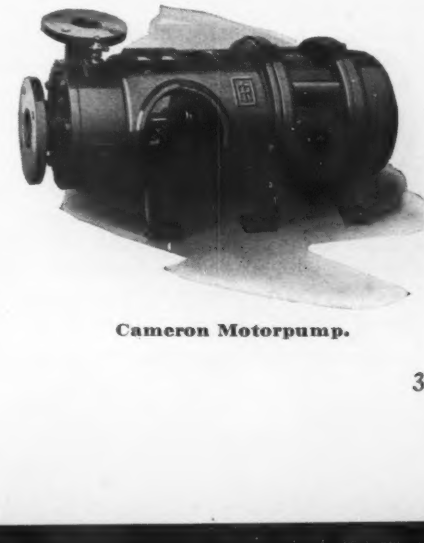
The tunnel through First Mountain is part of a system that had its beginning in 1902; and that work, as well as all subsequent developments having to do with the joint outlet sewer scheme, has been planned and supervised by Alexander Potter, consulting engineer, with Seth G. Hess as resident engineer.

SMALL CAMERON PUMP FOR GENERAL SERVICE

A LINE of small, general-service centrifugal pumps, ranging in capacity from 10 to 800 gallons a minute, has been announced by the Ingersoll-Rand Company. The Motorpump, as the type is known, is designed for any work requiring a pump of medium size to operate against moderate heads.

Both the pump and the electric motor which drives it are assembled as a single unit and with a common shaft, making a compact, light-weight pump that requires little floor space and can be easily installed. No foundation or baseplate is needed; but the latter can be furnished if desired. It can be mounted upside down, vertically, or in any other position that may happen to be most convenient; and the discharge nozzle can be turned to anyone of four positions. There are but two bearings in the Motorpump. These are of the ball type and require lubrication but once a year. It has only a single stuffing box, and this is readily accessible.

Cameron Motorpumps have many applications; and they are especially suitable for use in connection with air-conditioning and with circulating, cooling, and water-supply systems in factories, warehouses, apartment buildings, swimming pools, etc., etc.



Cameron Motorpump.

Showing an air-operated snubber in its accustomed surroundings, a coal mine. A tool of this kind is being used to advantage in driving gad holes in large blocks of quarried stone to facilitate splitting them.

AIR-OPERATED SNUBBER PUT TO NEW USE

FROM South Africa comes an example that demonstrates the adaptability of air-operated tools to fields of work outside their intended scope with resulting savings over previously used methods. In this case, a snubber—a tool that is designed primarily for use in coal mining—has been successfully applied to the cutting of holes in the faces of large blocks of quarried stone to assist in breaking them along desired planes.

The new method, which produces a superior job in a fraction of the time formerly required, has been put in operation at the Bon Accord Quarry—Pretoria's municipal quarry. It was developed by W. H. Johnston, manager of the quarry, in collaboration with engineers of the Ingersoll-Rand Company at Johannesburg.

The stone is a hard, tough variety of basalt known as norite. To split the blocks into the desired sizes, the plug-and-feather method was first used. This was effective, but it required a row of holes of such depth and diameter that a great deal of work had to be done afterwards in removing the semicircular depressions left on the two split faces. Accordingly, gads, or wedge-shaped steels, were adopted for the splitting of the stone. Since the gads left marks only about 1½ inches in depth, as compared to 5 inches by the plug-and-feather method, a considerable saving was effected in subsequently dressing the stone.

The procedure was to place a row of gad holes in a line along which the stone was to be split. Steel wedges were then driven into these holes and alternately struck. In this manner sufficient outward pressure was ultimately secured to cleave the stone along the line of holes. The gad holes were about 2 inches by ¾ inch in section. On the long side they tapered to nothing at a depth of 1½ to 2 inches. These holes were cut by hand by native laborers using hammers and punches. This was a laborious and expensive job, which is now being done with the aid of the air-operated snubber.

The snubber is, in effect, a mechanical pick that is employed in increasing the undercut of coal seams, in breaking down slate, and in mines, generally, where its services can be utilized to advantage. It is an outgrowth of the well-known paving breaker, and is constructed on similar lines. However, its weight is only nineteen pounds, making it easy to handle.

In cutting the norite, three tools are used with the snubber. The first, a 6-point rectangular surfacing tool, indents the rock to a depth of about ⅜ inch. The second is blunt-nosed chisel which carries the hol down an additional ⅜ inch. A moil or punc is then fitted to finish the hole—a rockin motion being given the snubber by the op erator. By this new method the gad hole are dr'ven in from 1 minute to 1½ minute each. By hand it required about 20 minute per hole.

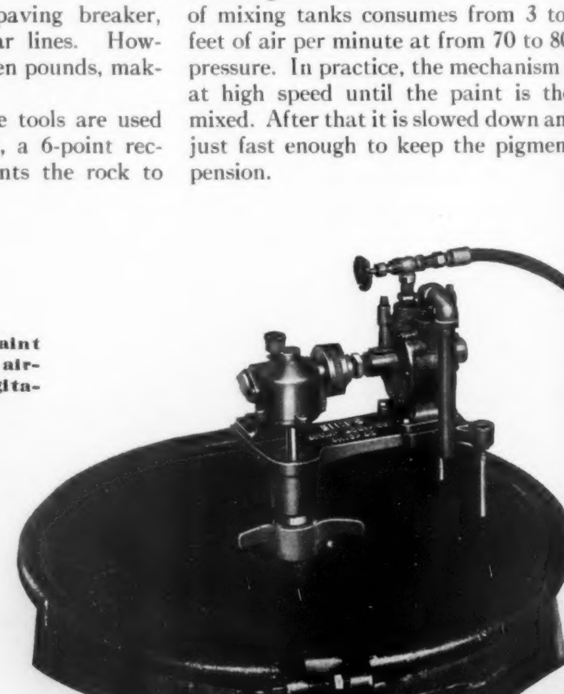
AIR-DRIVEN PAINT MIXER

INDUSTRIAL establishments that are re quired to use paint, lacquer, etc., in sur facing and finishing manufactured com modities know that the pigment and th vehicle must at all times be well mixed so a to assure uniformity of color—that is, satisfactory product. Stirring with a stic may do well enough for odd jobs; but in th day of quantity output there is no place in factory for an old-fashioned method such a this which, at the best, is only a makeshif Like the brush, the stick is giving way t mechanical facilities that are in keeping wit modern practices.

Paint-spraying is done with compresse air; and it is therefore not surprising that on of the newest of the mixing apparatus on th market is driven by an air motor. The equip ment is compact and can be attached directl to an agitator inserted in a standard ste drum or can be mounted on a metal stand s as to rotate at one and the same time as man paddles as there are tanks on the stand. On of these stands or racks comes in section holding ten 1-gallon tanks, and has been de signed especially to simplify the work touching up defects and making repairs in cident to finishing automobiles on the a sembly line—work that calls for the use different colors.

The paddle or paddles are rotated throug worm-and-gear drive. Air at a pressure from 50 to 70 pounds is needed to operate th barrel agitator, while each unit in the batter of mixing tanks consumes from 3 to 9 cub feet of air per minute at from 70 to 80 poun pressure. In practice, the mechanism is driv at high speed until the paint is thorough mixed. After that it is slowed down and mov just fast enough to keep the pigment in su pension.

Standard steel paint barrel with the air-motor-driven agitator attached.



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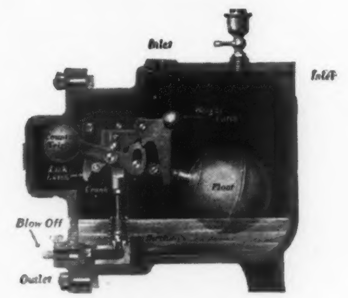

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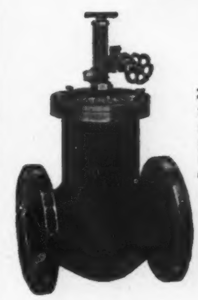

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Fig. 710 Jenkins Air Gun, complete with regular tip and hose nipple

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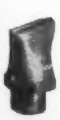

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